ENVIRONMENTAL FATE AND EFFECTS RISK ASSEMENT
Azinphos-Methyl

July 15, 1999

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RISK ASSESMENT

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July 15, 1999

U.S. EPA
Office of Pesticide Programs
Environmental Fate and Effects Division (7507C)
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES, AND
TOXIC SUBSTANCES

PC Code: 058001
Case No.: 0234
Date 7/15/99

MEMORANDUM:

SUBJECT: Azinphos-methyl: Revision of Draft EFED Reregistration Eligibility Decision (RED) Science Chapter to Include 60 Day Comments

FROM: Jean Holmes, Veterinarian (Team Leader) Jean E. Holmes 7/15/99
Dave Jones, Agronomist (Fate and Water Resource Assessment) R Dave Jones 7/16/99
William Erickson, Biologist (Terrestrial Assessment) William Erickson
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Environmental Fate and Effects Division (7507C)

THRU: Betsy Behl, Chief
Fate and Monitoring Branch
Environmental Fate and Effects Division (7507C)

TO: Barry O Keefe, Chemical Review Manager
Reregistration Branch 2
Special Review and Reregistration Division (7508C)

Attached please find a revised EFED Reregistration Eligibility Decision (RED) science chapter for azinphos methyl. This revised science chapter incorporates some of the comments identified in the EPA-OPP docket during the comment period. The documents in the OPP docket were as follows:

o "Response to the Draft EFED Reregistration Eligibility Decision (RED) Science Chapter for Azinphos-methyl, List A Case 0235" (letter from Bayer);

o "Public Response to the Draft EFED Reregistration Eligibility Decision (RED) Science Chapter for Azinphos-methyl, List A Case 0235", Docket #OPP-34131A (letter from Bayer dated 3/15/99;

o Letter from Washington State University (Erick Johansen, Pesticide Registration Specialist Pollinator Protection, Pesticide Management Division); and

o Letter from the Almond Hullers and Processors Association (Gene Beach, Manager).

Revisions to the science chapter were only required in the fate and water resource sections of the document. It should be noted that these revisions attempt to better clarify

EFED's risk assessment, but do not change the overall risks associated with the use of azinphos methyl.

More detail was provided in the EFED science chapter for the following topics identified in the comments:

o An aerobic aquatic metabolism study (MRID 4411801).

o Groundwater monitoring data from Virginia in the Pesticides in Ground Water Database.

o Bayer's proposed annual limitation of number of applications on cotton is 4

o Studies submitted by the registrant relating to the exposure in surface water due to the use of azinphos methyl on almonds and apples.

o Analytical method associated with monitoring data from the USGS National Water Quality Assessment (NAWQA) data base.

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Appendices

1. Use Characterization

Azinphos methyl has 51 agricultural uses from 13 products by 5 different registrants the current labels. However, a few of these crops dominate the total usage. Apples alone represented over 40% of the total use. In order of decreasing use, the major use crops for azinphos methyl are apples, cotton, almonds, pears, peaches, walnuts, potatoes, sugarcane, blueberries, plums, and cranberries according to the current BEAD estimates. Together, these crops represent 91% of the azinphos methyl usage. Around 2 million pounds are applied per year on average with a maximum of 5 million pounds (Neil Anderson, personal communication to Barry O'Keefe, 1999).

In 1997, azinphos methyl had the seventh highest use of all insecticides[1]. Azinphos methyl is geographically restricted to several high use locations including the Mississippi Delta, the Blue Ridge Mountains, the Texas Panhandle, central Washington, the Central Valley of California and Michigan (Figure 1).

[1] Personal communication from Jerry Hannan, based on data from the National Agricultural Statistics Service.

Azinphos methyl is dominantly used as a foliarly applied spray to control a variety of insects such as codling moth, boll weevil, and plum curculio. It is usually applied as an aerial spray for field crops and as a spray blast application on orchard crops. It is usually applied during the growing season, but can be applied as dormant spray to almonds. An ultra-low volume (ULV) spray application can be applied to some field crops including cotton. All five registrants have recently submitted a requests to cancel 13 uses. These were all minor uses for azinphos methyl and these cancellations should have little impact on the overall risk posed by azinphos methyl.

Rather than exhaustively assess all uses, this assessment has been focused on the dominant uses of azinphos methyl. For aquatic assessment, the uses assessed were almonds, apples, cherries, cotton, filberts, peaches, pears, plums/prunes, potatoes, sugar cane and walnuts. The apple assessment also covers the minor crop crab apples as the use patterns are identical. The terrestrial assessment assessed major uses and most of the minor uses.

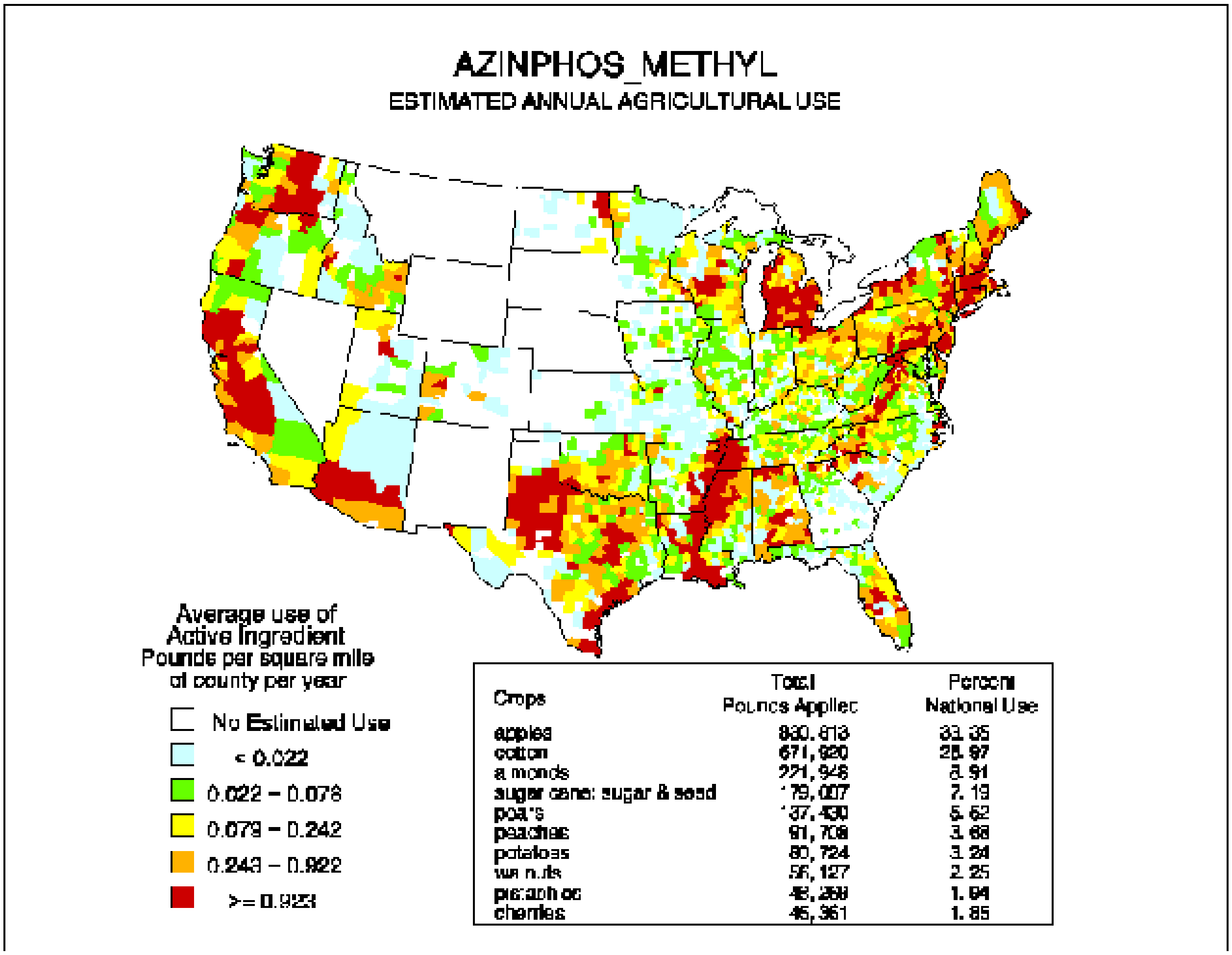

Figure 1. The estimated annual agricultural use of azinphos methyl in the United States (USGS, 1998).

2. Exposure Characterization

a. Chemical Profile

Common Name:	azinphos methyl
Chemical Name:	O,O-dimethyl S-[4-oxo-1,2,3-benzotriazin 3(4H)-yl)methyl] phosphoro-dithioate
CAS Number:	86-50-0
PC Code:	058001
Structure:	see Figure 2
Molecular Formula:	$C_{10}H_{12}N_3O_3PS_2$
Class:	organophosphate
Physical/Chemical Properties	
Molecular Mass:	317.32 g C mol^{-1}
Physical State:	white to beige granular material
Melting Point:	67-70° C
K_{ow}:	543
Vapor Pressure:	2.20 x 10^{-7} torr
Solubility in Water:	25.10 mgCL^{-1} at 25° C
Henry's Law Constant:	3.66 x 10^{-9} m^3Cmol^{-1} (calculated)

b. Environmental Fate Assessment

Summary

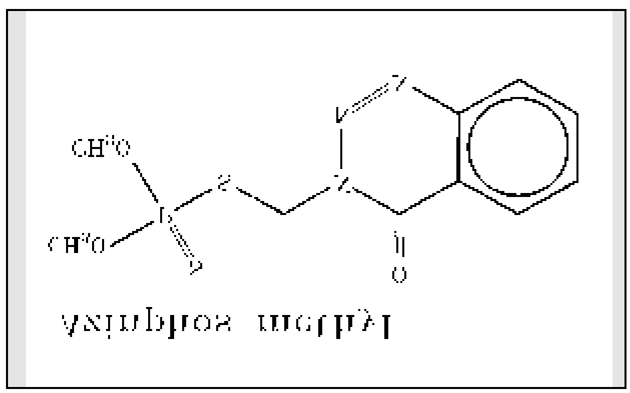

Figure 2. Molecular structure of azinphos methyl.

Azinphos methyl (Figure 2) is mobile (K_f = 12-27) and can reach surface water dissolved in runoff but not likely to leach to ground water in most situations. It is moderately persistent with aerobic soil metabolism DT_{50} of 27 d. It degrades rapidly by direct aqueous photolysis ($T_{1/2}$ = 77 h), but rather slowly by soil photolysis ($T_{1/2}$ = 180 d). Hydrolysis is alkaline catalyzed and is fairly rapid at high pH, on the order of several days. It is moderately persistent at acid and neutral pH. There is some uncertainty in the assessment of the hydrolysis data because data were not collected below 30° C. There is data on the degradates formed through aerobic aquatic metabolism, but no usable rate data is available.

Degradates include anthranilic acid, methyl anthranilate, azinphos methyl oxygen analog, mercaptomethyl benzazimide, hydroxymethyl benzazimide, benzazamide, and *bis*-methyl benzazamide sulfide, and methyl benzazimide sulfonic acid. The processes which produced each degradate are listed in Table 3. Because of the limited concentrations of the identified degradates and their properties, this risk assessment has been based solely on the parent. To the extent toxic degradates were present but not considered, the risk is commensurately increased. However, we do not believe this to be a major limitation of this assessment, since all levels of concern are already exceeded and we have high confidence that impacts are occurring from the incident data.

A second source of uncertainty in the fate assessment is due to the field dissipation studies. The two guideline studies are both from California and are of limited quality due to very poor recoveries at initiation of the study. In addition, these studies were run on fairly alkaline soils (pH = 6.9 - 8.7), so they represent locations where azinphos methyl would be expected to be least persistent. Two non-guideline studies from Georgia and Mississippi suggest that DT_{50}'s in Southeast may be relatively short, at 3 and 8 days respectively. However, these studies only sampled the top inch of soil.

In general, the laboratory fate data for parent azinphos methyl provides a reasonable level of confidence for the risk assessment. In contrast to most other pesticides, there is a fair amount (7 values) of foliar dissipation data. Additional metabolism data would increase our confidence in the chronic exposure assessment and may result in reduced EEC values.

Abiotic Hydrolysis

An hydrolysis study (MRID 40297001) was conducted at three pH's (4, 7, and 9) and two temperatures (30° C and 40° C). This study was acceptable for regulatory purposes. Note that the standard guideline hydrolysis study is conducted at pH's 5, 7, and 9 and at a single temperature of 25° C. Starting concentrations of 1 mg L^{-1} and 10 mg L^{-1} were tested for each set of conditions for a total of 12 test systems. Rate constants were the same regardless of the starting concentration as would be expected if a first order degradation model holds true. The rate constants were estimated using linear regression of log-transformed data. The corresponding half-lives as a function of pH and temperature are listed in Table 1. The Arrhenius equation was used to correct for the temperature and estimate half-lives at for pH 5, 7, and 9 by extrapolation from the higher temperature data. These 25° C half lives are 38 d, 37 d, and 6.9 d respectively.

Several degradates were found at concentrations greater than 10% of the parent. In general, starting concentration and temperature did not appear to affect the amount of each degradate that was found after 30 days. Mercaptomethyl benzazimide was found at 4.9% to 10.4% after 30 days in pH 7, hydroxymethyl benzazimide and benzazimide, which were measured as single analyte, were found after 30 days at 8.1% to 12.2% at pH 4, 6.0 to 14.2% at pH 7, and 32.4 to 38.9% at pH 9.as a single anthranilic acid, was identified a concentration above 10% of the applied parent. Anthranilic acid was found at between 18.1 and 22.8% of the parent a 30 days in the pH 9 test systems. An unidentified degradate which was possibly an ester of was found in the pH 9 test systems at 7.4% to 14.5%. *Bis*-methyl benzazamide sulfide was also found at concentration less than 10% of the applied radioactivity.

Table 1. Half-life of azinphos methyl as function of pH and temperature.			
Temperature	ph 4	pH 7	pH 9
30 C	49 d	26 d	3.7 d
40 C	23	13	1.8

Photolysis

Azinphos methyl degrades by photolysis on both soil and in water. In the aqueous photolysis experiment (MRID 40297001) conducted at pH 4.35 and 30°C, a direct photolysis half-life of 76.7 hours was estimated from the first order rate constant calculated using linear regression on log-transformed data. Note that while the standard guidance is for the study to be conducted at 25° C the data was found to acceptable for regulatory use as photolysis is usually relatively insensitive to temperature. The experiment was run in January in Kansas City with natural sunlight over 87 hours. Two major degradates were identified, benzazimide and anthranilic acid. In this experiment, each 'degradate' actually is a complex of two degradates that could not be separately identified by the analytical procedure used in the study. The benzazimide complex consisted of benzazimide and (1N)-methoxybenzazimide while the anthranilic acid complex consisted of anthranilic acid and methyl anthranilate ester. Benzazimide complex represented 39.1% of the radiolabeled residues at the end of the experiment, the anthranilic acid complex reached 7.2% of the radiolabeled residues at the end of experiment.

In a soil photolysis experiment (MRID 40297002) done with natural sunlight in January through April in Kansas City, Missouri, the photolysis half-life corrected for the dark control was 180 d. The data from this study is acceptable for regulatory use. The soil was an unidentified sandy loam from Stanley, Kansas with a pH of 5.1. The half-life was estimated from rate constants calculated by linear regression on log-transformed data. Eighty-nine per cent of the initial radioactivity remained after 31 d in the dark control where as 79% was present in the irradiated test system. The soil used was an unidentified sandy loam. No specific degradates were identified and none exceeded 4% of the applied radioactivity at any point during the experiment.

Metabolism

There is one submitted aerobic soil metabolism study for azinphos methyl (MRID 29900). The study was conducted on an unidentified sandy loam soil. Ten measurements were made over the course of 1 year. The DT_{50} was 27 d and the DT_{90} was 146 d as estimated by exponential interpolation. The reaction does not appear to follow first-order kinetics, hence a half-life estimate is inappropriate. However, since the current environmental fate models require first order rate constant, an estimate was generated using non-linear regression on the untransformed data. This method often provides estimates that better describe the data when there is significant lack of fit of the first order model, as is the case here. The half-life estimate generated using this method was 32 d. No single identified metabolite was found at greater than 10% of the applied radioactivity; the oxygen analog of azinphos methyl (azinphos methyl oxon) peaked at 5.3% of the applied radioactivity 186 d after application. Four benzazamide metabolites, namely mercaptomethyl benzazimide, hydroxymethyl benzazimide, benzazamide, and *bis*-methyl benzazamide sulfide, were reported as a single analyte, with a maximum of 12% of the applied occurring at 120 d. Only 4.1 % of residues were trapped as volatiles in a NaOH trap; this is likely to have been CO_2. Seventy-two per cent of the radioactivity was in unidentified soil bound residues at the end of the experiment.

A single anaerobic soil metabolism was submitted (MRID 29900). This study was found to be acceptable for regulatory use. In this study, the soil was incubated aerobically for 30 d, prior to flooding and purging with nitrogen. Three samples were collected and analyzed over the subsequent 60 d duration of the study. Forty four percent of the applied radioactivity was present at the initiation of anaerobic conditions and 24% was present as azinphos methyl at the completion of the study 60 d later. No DT_{50} was estimated as the less than 50% of the parent that was present at the initiation of anaerobic conditions was degraded during the course of the study. The data was fit to a first order degradation model using linear regression of log-transformed data, resulting in a half-life estimate of 66 d. The confidence in this estimate is low since it is based on only three measurements. No single metabolite was present at greater than 10% of the application rate. At the conclusion of the study, 50% of the radioactivity was present as unidentified soil bound residues.

A single aerobic aquatic metabolism study was submitted (MRID 44411801). This study was found to provide supplemental data on the degradates, but not to be fully acceptable. The study is not upgradeable. Eight or nine degradates of azinphos methyl were found in the two systems: *des*-methyl azinphos methyl, *des*-methyl azinphos methyl S-methyl isomer, methyl benzazimide, methylsulfinyl methyl benzazimide, methylsulfonyl methyl benzazimide, methyl benzazimide sulfonic acid, methylthiomethyl benzazimide, and either/or hydroxy-methyl benzazimide/benzazimide. The last two degradates were not resolved by the chromatography. Only methyl benzazimide sulfonic acid occurred at greater than 10% (11.4%) of the nominal concentration. The study could not be used to establish the rate of azinphos methyl degradation under aerobic aquatic conditions.

Foliar Degradation and Washoff

A major route of dissipation for azinphos methyl is foliar degradation and washoff. There are seven measurements available for foliar degradation of azinphos methyl (See Table 2), six from the open literature and one from a study submitted by the registrant. Note that there are currently no requirements nor guidance for the conduct for foliar degradation and washoff studies. The study by the registrant was conducted concurrently with a runoff study at Benoit, Mississippi (Coody 1992). The mean dissipation half life over these studies was 7.2 d. The background variability among studies is fairly high, F = 4.9 d. Note that most of these studies are field studies, so they may include washoff.

Note also that there is some evidence (see Jones, D190581. McDowell, 1984) that foliar dissipation is not a first order process, so the half lives used in this calculation may not accurately reflect the true degradation process on foliar surfaces for azinphos methyl. There were no degradate data in these studies.

One washoff estimate was available for azinphos methyl.(Gunther et al, 1977). This study showed that 60% of the azinphos methyl of leaf surfaces washed of with 0.33 cm of simulated rainfall. This would correspond to a first order washoff rate constant of 0.937 cm^{-1}. A description of the method of estimating the washoff rate constant is in Jones, 1998.

Table 2. Foliar dissipation half-lives for azinphos methyl.

Half-life (days)	Source
1.6	Hoskins, 1961
7.9	Hoskins, 1961
5.2	Hoskins, 1961
7.4	Pree *et al.*, 1976
9.8	Pree *et al.*, 1976
16.0	Winterlin *et al.*, 1974
2.56	MRID 425167-02

Table 3. Degradates found in azinphos methyl studies.						
Degradate	Soil Photolysis	Aqueous Photolysis	Hydrolysis	Aerobic Soil Metabolism	Aerobic Aquatic Metabolism	Anaerobic Soil Metabolism
des-methyl azinphos methyl					X	
des-methyl azinphos methyl S-methyl isomer					X	
anthranilic acid		X	X			
methyl anthranilate		X				
benzazimide		X	X	X	X	
azinphos methyl oxygen analog				X	X	
hydroxymethyl benzazimide		X	X	X	X	
mercaptomethyl benzazimide			X	X		
bis-methyl benzazamide sulfide			X	X		
methyl benzazimide					X	
methylsulfinyl methyl benzazimide					X	
methylsulfonyl methyl benzazimide					X	
methyl benzazimide sulfonic acid					X	
methylthiomethyl benzazimide					X	

Batch Equilibrium/Mobility

Soil water partition coefficients were estimated from batch equilibrium studies for three unidentified soils (MRID 42959702). K_f values for adsorption varied from 7 to 17 and varied from 12 to 28 for desorption (See Table 4). In all cases 1/n values were less than 1, indicating that the adsorption/desorption isotherms are not linear. Binding of azinphos methyl to soil was not significantly correlated to soil organic carbon content (R^2 = 51%). These values suggest that azinphos methyl should not be particularly mobile by leaching but should be relatively mobile to surface waters in the dissolved form in runoff. An aged soil column leaching study (MRID 00029887) confirmed the low mobility by leaching of azinphos methyl and its degradates: 90% of the radioactivity was in the top 5 cm of the column after leaching with 35.5 cm of water over 45 d. The soil material was aged for 28 d and then dried before being packed into the column. A total of 4.4% of the radioactivity leached from the bottom of the 30.5 cm column.

Table 4. Fruendlich Adsorption and Desorption constants for azinphos methyl on four soils.

Soil Texture	% Organic Carbon	K_f for adsorption	1/n for adsorption	K_f for desorption	1/n for adsorption
sandy loam	1.6	7.6	0.83	12.3	0.86
silt loam	2.9	16.8	0.82	27.5	0.94
silty clay	0.3	9.8	0.93	12.3	0.95

Bioaccumulation

A bioaccumulation study is not required as the K_{ow} is less than 1000. The K_{ow} of azinphos methyl is 543.

Spray Drift

Because azinphos methyl products can be applied by aircraft or spray blast equipment, droplet size spectrum (201-1) and drift field evaluation (202-1) studies are required to characterize the potential for offsite drift. The Spray Drift Task Force (SDTF), a consortium of pesticide registrants has been formed to generate the data to meet these data requirement in a generic manner. The SDTF has submitted to the Agency a series of studies which are intended to characterize spray droplet drift potential due to various factors including application methods, application equipment, meteorological conditions, crop geometry and droplet characteristics. EPA is currently evaluating these studies. In the interim, the Agency is relying on previously submitted spray drift data an the open literature for estimating the potential of off-target drift. After the data review is finished, the Agency will determine whether a reassessment of the potential risks from spray application of azinphos methyl is warranted.

Field Dissipation Studies

Four terrestrial field dissipation studies are available for azinphos methyl. The first two were submitted to satisfy the terrestrial field dissipation guideline. The second two were submitted in conjunction with runoff studies. They provide supporting information on the dissipation of azinphos methyl under some conditions but do not satisfy the guideline requirement. The first two (MRID 42647901) were conducted in California on alfalfa fields. There were no uncropped plots at either site. One of the studies was conducted at Watsonville, California on a Salinas silt loam where azinphos methyl was applied in July. The pH of the soil at this site ranged from 6.9 to 8.0. We would expect azinphos methyl to degrade more rapidly under these pH conditions when compared to most agricultural fields where the pH is acid to neutral. The duration of the experiment was 60 days. There were two plots, one receiving one application of 3 lb acre^{-1}, and the other receiving two applications 7 days apart at the same rate. Parent azinphos methyl degraded with a DT_{50} of 9 days (estimated by exponential interpolation) from the upper 6 inches of soil in the single application plot. The DT_{50} was bracketed by 7 and 14 days after the second application in the two application plot. Azinphos methyl was only detected in one sample below 6 inches after 28 days in the single application plot. Only one degradate, azinphos methyl oxygen analog, was analyzed, but was not detected. The quantitation limit for both parent and degradate was 0.01 mgCkg^{-1}. A total of 12.9 inches of rain plus irrigation was applied to the plots during the course of the study. However, no evapotranspiration data was supplied so it is not possible to assess leaching with the data provided. The value of this study is limited, because the recovery at time 0 was only 55% and there was no uncropped plot.

The same experimental setup was used at the Fresno site. Applications were made in May. The soil here was a Hesperia fine sandy loam. The pH of the soil at this site ranged from 7.6 to 8.7. As with the previous study, we would expect azinphos methyl to degrade more rapidly under pH conditions such as this as compared to most other agricultural fields where the pH is acid to neutral. The experiment was conducted for 60 days. The DT_{50}, estimated by exponential interpolation was two days in the single application plot, and bracketed by 7 and 14 days in the 2 application plot. No azinphos methyl was detected below the top 6 inches. Azinphos methyl oxygen analog was detected once in the top layer at the quantitation limit of 0.01 mgCkg^{-1}. A total of 16.2 inches of rainfall and irrigation were applied to the plots during the study, but as in the previous study, no evapotranspiration data was collected so leaching at the site cannot be assessed. The recovery of azinphos methyl at time zero was 60%and there was no uncropped plot, limiting the utility of this study.

The two other field dissipation studies were conducted in conjunction with runoff studies in cotton fields in Colquitt County, Georgia (MRID 425167-02) and Benoit, Mississippi (MRID 425167-01). They provide marginal data, as no samples were collected at zero time, no samples were collected below the top inch, and degradates were not analyzed. The soils at the Colquitt County site were an Alapaha sandy loam, a Carnegie sandy loam, a Tifton loamy sand, and a Tifton sandy loam. The soils at the Benoit site were dominantly a Bosket very fine sandy loam with smaller amounts of Dubbs very sandy loam. A single application of 0.25 lbCacre^{-1} was made to the Colquitt County site on August 7 and to the Benoit site on August 22. The DT_{50} at the Colquitt County site was 3 d, and

8.2 d at the Benoit site. It is possible that these dissipation rates include a substantial amount of leaching as the sampling depth was so shallow.

Field Runoff Studies

Two runoff studies were conducted to measure pesticide runoff under field conditions. These studies provide supplemental information on runoff potential of azinphos methyl. These studies were voluntarily submitted by the registrant. There is currently no requirement nor guidance for conducting field runoff studies. The studies were conducted in Colquitt County, Georgia (MRID 425167-02) and Benoit, Mississippi (MRID 425167-01) in cotton fields.

At the Mississippi site, a total of 14.9 g of azinphos methyl ran off the 5.2 acre plot in a storm of 3.08 inches on August 9, 1989. Approximately 31.5% of the precipitation ran off the plot during the rainfall event. Although the study was otherwise well-conducted, the method used to confirm the application rate (collection of the spray on cards placed in the field during application) was only able to collect ~20% of nominal application rate. It is difficult, if not impossible, to make accurate assessments of the fate of the pesticide when the amount and distribution of the pesticide immediately following application cannot be determined. We can therefore only say that the percent of azinphos methyl that ran off the field was between 0.9% (based on spray tank calibration of the nominal application rate) and 3.5% (based on the spray card recovery). It is more likely to be the former of these values as the pesticide mass on the spray cards are not reflective of the application rate due to interception from adjacent foliage.

The rainfall event represented a storm with a one in seven year return frequency during the summer in this part of Mississippi. The return frequency of the runoff event is somewhat less than that for the precipitation event, as the soil was fairly dry due to lack of precipitation in the week prior to the runoff event. Furthermore, because this study was conducted later in the season than when most azinphos methyl is applied, the canopy was more closed than would usually be the case. The site represents what appears to be a fairly typical site for cotton culture. However, data was not provided that would allow a more precise estimate of how likely the site was to produce adverse aquatic exposures, as compared to other cotton agricultural sites.

To summarize the results from Mississippi, the runoff event in the study represents a less than one in seven year event on a typical site. It generated between 0.9% and 3.5% of the applied azinphos methyl in the runoff, with the value more likely to be close to the 0.9% value.

At the Colquitt County, Georgia site, the field occupied 49 acres of a 50 acre watershed and drained into a 3.5 acre pond. Nine acres of the field was separated from the rest of the field with a berm. This isolated area was used to quantify the runoff and the azinphos methyl in it. Eight applications of azinphos methyl were made at three day intervals starting on August 1.

A total of 13.3 g of azinphos methyl ran off the 9 acre portion of the field in four storms which occurred on August 8 (32 mm), August 26 (61 mm), August 31 (37 mm), and October 1 (33 mm). These produced 3.6 g, 8.3 g, 1.3 g and 0.0012 g of azinphos methyl in the runoff, respectively. The method used to confirm the application rate (collection of the spray on cards placed in the field during application) showed about 75% of nominal application rate was reaching the study site on average. A second method of confirmation, using the tank calibration data, along with measurements of the azinphos methyl in the spray solution gave a separate estimate of the application rate. This method generally gave higher estimates than the spray cards. It is more likely that the tank calibration method is the more accurate of these estimates, as the pesticide mass on the spray cards may not be reflective of the application rate due to interception from adjacent foliage. The percent runoff was calculated both by using the application estimate based on the tank calibration measurements and upon the amount found on the spray cards. The percent azinphos methyl in runoff ranged from 1.7×10^{-4} to 0.17% using the tank calibration data and from 2.2×10^{-4} to 0.26% based on the spray cards. The total applied that ran off was 0.18% by the tank calibration method and 0.24% by the spray card method. Measurements of the sediment transported from the 9 acre study area ranged from 22 kg due to the October 31 runoff event to 2,200 kg for the August 26 event. The concentration of azinphos methyl on the sediment was not determined. The mean azinphos methyl concentration in the pond was about 2 and 3 : g C L^{-1}. However, the variance among the measurements in the pond was very high in the first few days after the runoff event as the pond did not yet appear to be well mixed. so the uncertainty is higher than would normally be the case.

Data were not provided on the return frequency of the runoff events. Some anecdotal information (a tornado occurred nearby) was provided on the return frequency of the August 26 storm, indicating that storms of that intensity (61 mm in 30 to 40 min) were relatively rare in that area. However, given the soil was likely to have been fairly dry before the event, it is likely that the runoff event (as opposed to the storm event) was not particularly severe. Furthermore, because this study was conducted later in the season than when most azinphos methyl is applied, the canopy was more closed than would usually be the case. The site represents what appears to be a fairly typical site for cotton culture in Georgia, but data was not provided that would allow a more precise estimate of how likely the site was to produce adverse aquatic exposures, as compared to other cotton agricultural sites. It should be noted that a fish kill of 500 to 1000 fish occurred in the pond adjacent to the site two days following the August 26 storm.

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To summarize the results from Georgia, four runoff events occurred in the study that moved less than 0.3% of the applied pesticide in runoff, but the relative frequency of the events and the relative severity of the site cannot be determined with the data provided.

Terrestrial Exposure Assessment

Nongranular applications:

The estimated environmental concentrations (EEC's) on potential bird and mammal food items following a single foliar application are based on Hoerger and Kenaga (1972) as modified by Fletcher et al. (1994). The predicted maximum and mean "Fletcher" EEC's from a direct single application of 1 lb ai/acre are tabulated below. EECs for other application rates are presumed to increase or decrease proportionally with an increase or decrease in the application rate.

Table 5. Estimated Environmental Concentrations on Avian and Mammalian Food Items (ppm) Following a Single Direct Application at 1 lb ai/A)

Food Items	EEC (ppm) Predicted Maximum Residue[1]	EEC (ppm) Predicted Mean Residue[1]
Short grass	240	85
Tall grass	110	36
Broadleaf/forage plants and small insects	135	45
Fruits, pods, seeds, and large insects	15	7

[1] Predicted maximum and mean residues are for a 1 lb ai/a application rate and are based on Hoerger and Kenaga (1972) as modified by Fletcher et al. (1994).

Predicted maximum and mean EECs resulting from multiple applications are calculated from EFED's "FATE" program. FATE estimates the highest one-day residue and the average residue, based on the maximum or mean day-0 EEC from the first application, the total number of applications and interval between applications, and a first-order degradation rate. The half-life used in fate was 9.8 days, which represents the upper 90% confidence bound on the mean of the foliar dissipation data.

Granular applications:

There are no granular formulations currently registered for azinphos methyl.

Water Resources Assessment

The water resources assessment is primarily based on laboratory data integrated with modeling and monitoring. Estimates were made to support both the drinking water assessment and the aquatic ecological risk assessment. For the drinking water estimates, except for the acute ground water, the true value was bracketed by monitoring data as a lower bound and the modeling values as an upper bound. The acute ground water estimate is based on monitoring data only. The drinking water assessment endpoints are presented in Table 6. The surface water upper bound values are from a Tier

2 assessment using PRZM and EXAMS. These values represent the eastern peaches use pattern which is the crop with the highest EEC's. The surface water lower bound values were estimated from the high use study units in the NAWQA program, the Central Columbia Plateau in Washington, the San Joaquin-Tulare Basin in California and the Potomac River Basin. For the chronic ground water, the upper bound was generated with the SCI-GROW model and the lower bound is from NAWQA data. The acute ground water value was estimated using a ground water study from the Shenandoah Valley. This study suggests that, at least under some conditions, azinphos methyl can reach ground water in substantial amounts. This value may be representative of karst terrain only or in other areas where transport is primarily via preferential flow. The chronic value was estimated using SCI-GROW for the eastern cotton use pattern.

For surface water, the values chosen for the drinking water exposure estimate lower bound represent a concentration at a 95th percentile site in a high use area. The sites in the NAWQA studies used to make the assessment are not at drinking water facilities for the most part; although some sampling locations are very close to drinking water intakes (see the Potomac NAWQA unit discussion below.) This represents some lower proportion of the population as, in general, larger drinking water facilities tend to draw from somewhat less contaminated water bodies. For assessment of acute effects, the peak value at each site was used. For assessment of chronic effects from ingestion of drinking water from surface water sources, the greatest annual mean at the site was used. Some sites were not considered in the surface drinking water assessment. Sites which were obviously inappropriate for drinking water use have been excluded from consideration in estimating the endpoint. Such sites include all waste ways, drainage ways and storm drains. Only facilities that had more than 6 samples taken were considered. In addition, because of the sample timing, it was not possible to generate annual means for some sites; these sites were, therefore, not considered. Finally, the sites in the Potomac study unit above the confluence of Conococheague Creek and all the tributaries entering the tidal Potomac were not considered as little or no orchard culture occurs in that portion of the basin.

Generally, monitoring data tends to underestimate exposures at the level of concern, particularly for acute exposure. This is because infrequent sampling is likely to miss the occasional occurrences of azinphos methyl in the water body. This was particularly problematic in the Potomac Basin as most of the sites were sampled only a single time. Among 113 samples collected and analyzed for azinphos methyl there were only four sites (*i.e.*3%) with detectable levels. By contrast, 11 of 40 sites in the San Joaquin area were sampled more than 6 times. Among 40 samples, nine (i.e. about 22%) had detectable levels of azinphos methyl. Monitoring also reflects the current use pattern at the time of the sampling. Modeling, by contrast, can reflect the effects of application at the maximum label rate. Monitoring also reflects the per cent area cropped in the basin and the per cent of crop treated, neither of which are considered with the current modeling practice.

Bayer has submitted some new labels which lower the number of applications of azinphos methyl for cotton. Further description of these estimates are provided below. The surface water estimates for use in the ecological risk assessment are presented in Tables 7-12. The methods used to calculate these values are described in Jones, 1998. A summary of that document is provided below. In addition to summaries of the modeling estimates, summary descriptions of the available monitoring data are also provided.

Table 6. Range estimates for drinking water exposure assessment for azinphos methyl. Lower bounds are estimated from monitoring data and the upper bound estimates are estimated with modeling.

Endpoint	Acute	Chronic
Surface Water	0.073 - 40.6 µg·L^{-1}	0.027-7.2 µg·L^{-1}
Ground Water	75 µg·L^{-1}	0.064-0.40 µg·L^{-1}

The original surface water upper bound values were based on the cotton use pattern which had an unlimited number of applications on some labels. Bayer has recently submitted a label amendment restricting the number of applications to 4 per year. If all registrants amended their cotton labels, restricting the number of applications to 4 per year, the EEC's for cotton in the drinking water assessment would be between the calculated 6 applications per year (50 µg·L^{-1} for acute and 6.7 µg·L^{-1} for chronic assessment) and 2 applications per year (5.1 µg·L^{-1} for acute and 1.1 µg·L^{-1} for chronic). Consequently, the crop with the highest surface water EEC's has become peaches and this is now being used for the upper bound drinking water estimates for surface water. The modeled acute and chronic surface drinking water assessment EEC values are now 40.6 µg·L^{-1} and 7.2 µg·L^{-1} respectively. The crops with the highest chronic ground water EEC's would be almonds, apples, filberts, pears and walnuts with a resulting chronic EEC of 0.40 µg·L^{-1} .

The drinking water estimates used for the upper bounds in the surface water assessment are expected to be substantially higher than that expected to be seen in the environment for reasons beyond those discussed in the modeling limitations section below. The modeled surface water estimates are based on the maximum application practice allowed on the label for peaches (see Table 13). The maximum use pattern used 2 lb acre^{-1} applied 4 time a year. The typical use pattern, based on a mean application rate (0.6 lb acre^{-1}) and number of applications (2) results in an acute estimate of 15.9 µg·L^{-1} rather than 40 µg·L^{-1}.

Table 15. Tier 2 upper tenth percentile EEC's for Bayer's azinphos methyl products applied to almonds.						
Product	Maximum	4 Day	21 Day	60 Day	90 Day	Annual Mean
Guthion 50% WP's*	8.3 :g·L^{-1}	7.8 :g·L^{-1}	6.2 :g·L^{-1}	4.8 :g·L^{-1}	3.9 :g·L^{-1}	1.7 :g·L^{-1}
Guthion 35% WP's, 2L**	8.0 :g·L^{-1}	7.5 :g·L^{-1}	5.9 :g·L^{-1}	4.6 :g·L^{-1}	3.8 :g·L^{-1}	1.1 :g·L^{-1}
typical use	5.6 :g·L^{-1}	5.3 :g·L^{-1}	4.2 :g·L^{-1}	3.2 :g·L^{-1}	2.7 :g·L^{-1}	0.8 :g·L^{-1}

* Includes two wettable powder formulations, 50% WP and Solupak
** Includes three formulations: 35% WP, and Solupak 35% WP and 2L.

Table 16. Tier 2 upper tenth percentile EEC's for Bayer Inc.'s azinphos methyl products applied to apples and crab apples.						
Product	Maximum	4 Day	21 Day	60 Day	90 Day	Annual Mean
Guthion WP's*	13.9 :g·L^{-1}	13.1 :g·L^{-1}	11.0 :g·L^{-1}	9.0 :g·L^{-1}	7.7 :g·L^{-1}	3.3 :g·L^{-1}
typical use, eastern U.S.	4.6 :g·L^{-1}	4.4 :g·L^{-1}	3.7 :g·L^{-1}	3.0 :g·L^{-1}	2.9 :g·L^{-1}	1.1 :g·L^{-1}
typical use, western U.S.	0.70 :g·L^{-1}	0.66 :g·L^{-1}	0.58 :g·L^{-1}	0.42 :g·L^{-1}	0.38 :g·L^{-1}	0.08 :g·L^{-1}

* Includes all four Guthion wettable powder formulations, 50% WP, Solupak 50% WP, 35% WP, and Solupak 35% WP, not registered for use on quince.

Table 17. Tier 2 upper tenth percentile EEC's for Bayer's azinphos methyl products applied to cherries.						
Product	Maximum	4 Day	21 Day	60 Day	90 Day	Annual Mean
Guthion WP's	10.7 :g·L^{-1}	10.2 :g·L^{-1}	8.6 :g·L^{-1}	6.7 :g·L^{-1}	5.6 :g·L^{-1}	2.4 :g·L^{-1}
typical use	5.1 :g·L^{-1}	4.98.1$_{1}$:g·L^{-}	3.9 :g·L^{-1}	3.3 :g·L^{-1}	3.0 :g·L^{-1}	1.1 :g·L^{-1}

Table 18. Tier 2 upper tenth percentile EEC's for Miles Inc.'s azinphos methyl products applied to cotton.						
Product	Maximum	4 Day	21 Day	60 Day	90 Day	Annual Mean
Guthion 3F*	87.8 µg·L^{-1}	83.8 µg·L^{-1}	69.2 µg·L^{-1}	49.5 µg·L^{-1}	40.4 µg·L^{-1}	13.4 µg·L^{-1}
Guthion 2L, 6 applications	48.8 µg·L^{-1}	46.6 µg·L^{-1}	40.5 µg·L^{-1}	27.5 µg·L^{-1}	21.8 µg·L^{-1}	6.7 µg·L^{-1}
typical use	8.4 µg·L^{-1}	8.1 µg·L^{-1}	7.0 µg·L^{-1}	5.2 µg·L^{-1}	4.1 µg·L^{-1}	1.3 µg·L^{-1}
*cancelled registration						

Table 19. Tier 2 upper tenth percentile EEC's for Bayer's azinphos methyl products registered for filberts.						
Product	Maximum	4 Day	21 Day	60 Day	90 Day	Annual Mean
all Guthions	9.3 µg·L^{-1}	8.8 µg·L^{-1}	7.1 µg·L^{-1}	5.7 µg·L^{-1}	4.8 µg·L^{-1}	1.5 µg·L^{-1}

Table 20. Tier 2 upper tenth percentile EEC's for Bayer's azinphos methyl products applied to pears.						
Product	Maximum	4 Day	21 Day	60 Day	90 Day	Annual Mean
Guthion WP's	8.9 µg·L^{-1}	8.5 µg·L^{-1}	6.8 µg·L^{-1}	4.9 µg·L^{-1}	4.8 µg·L^{-1}	1.9 µg·L^{-1}
typical use	5.2 µg·L^{-1}	4.9 µg·L^{-1}	4.0 µg·L^{-1}	2.9 µg·L^{-1}	2.8 µg·L^{-1}	1.0 µg·L^{-1}

Table 21. Tier 2 upper tenth percentile EEC's for Bayer's azinphos methyl products applied to peaches.						
Product	Maximum	4 Day	21 Day	60 Day	90 Day	Annual Mean
all Guthions	40.6 µg·L^{-1}	38.7 µg·L^{-1}	33.5 µg·L^{-1}	25.5 µg·L^{-1}	21.2 µg·L^{-1}	7.2 µg·L^{-1}
typical use	15.9 µg·L^{-1}	15.2 µg·L^{-1}	13.2 µg·L^{-1}	10.2 µg·L^{-1}	8.5 µg·L^{-1}	3.0 µg·L^{-1}

alt. row middle app.	15.8 µg·L^{-1}	15.0 µg·L^{-1}	13.1 µg·L^{-1}	10.4 µg·L^{-1}	9.0 µg·L^{-1}	3.1 µg·L^{-1}

Table 22. Tier 2 upper tenth percentile EEC's for Bayer's azinphos methyl products applied to plums and prunes.

Product	Maximum	4 Day	21 Day	60 Day	90 Day	Annual Mean
all Guthions	8.0 µg·L^{-1}	7.5 µg·L^{-1}	5.9 µg·L^{-1}	4.6 µg·L^{-1}	3.8 µg·L^{-1}	1.1 µg·L^{-1}
typical use	2.5 µg·L^{-1}	2..1 µg·L^{-1}	1.9 µg·L^{-1}	1.2 µg·L^{-1}	0.9 µg·L^{-1}	0.3 µg·L^{-1}

Table 23. Tier 2 upper tenth percentile EEC's for Bayer's azinphos methyl products applied to potatoes.

Product	Maximum	4 Day	21 Day	60 Day	90 Day	Annual Mean
all Guthions	13.6 µg·L^{-1}	12.9 µg·L^{-1}	10.4 µg·L^{-1}	7.6 µg·L^{-1}	6.2 µg·L^{-1}	1.9 µg·L^{-1}

Table 24. Tier 2 upper tenth percentile EEC's for Miles Inc.'s azinphos methyl products applied to sugar cane.

Product	Maximum	4 Day	21 Day	60 Day	90 Day	Annual Mean
Guthion 3*	22.2 µg·L^{-1}	20.9 µg·L^{-1}	17.5 µg·L^{-1}	14.8 µg·L^{-1}	12.5 µg·L^{-1}	4.1 µg·L^{-1}
cancelled registration						

Table 25. Tier 2 upper tenth percentile EEC's for Bayer's all azinphos methyl products applied registered for walnuts.

Product	Maximum	4 Day	21 Day	60 Day	90 Day	Annual Mean
all Guthion	12.0 µg·L^{-1}	11.3 µg·L^{-1}	9.1 µg·L^{-1}	7.3 µg·L^{-1}	6.2 µg·L^{-1}	1.9 µg·L^{-1}
typical use	3.6 µg·L^{-1}	3.4 µg·L^{-1}	2.8 µg·L^{-1}	1.8 µg·L^{-1}	1.4 µg·L^{-1}	0.4 µg·L^{-1}

Surface Water Assessment

The surface water assessment has been primarily based on Tier 2 modeling (PRZM-EXAMS). Monitoring data from STORET, two studies from the United States Geological Survey, and the state of Florida have been reviewed and summarized here. Modeling has been done for the high use crops and a limited set of lower use crops that receive azinphos methyl applications. These crops are almonds, apples (and crab apples), cherries, cotton, peaches, pears, plums and prunes, potatoes, and walnuts.

In addition, several studies have been submitted by the registrant relating to the exposure in surface water due to the use of azinphos methyl on almonds and apples. Summaries of these studies are included after the modeling discussion.

STORET. U.S. EPA's Office of Water maintains the STORET database. The data in STORET is predominantly entered and maintained by individuals and groups outside the Agency. Consequently, the data in STORET is highly variable in quality, depending on how and why the data was originally generated. A particular shortcoming of STORET for use in risk assessment is the loss of 'context': It is difficult to determine the purpose and circumstances of the data from the information contained in the database. A particular problem for pesticides is that measurements are often made at places and times when you would not expect the chemical to be present. STORET therefore serves more as an indicator of potential presence in water than as a tool for risk assessment. The measurements of azinphos methyl in several different kinds of water bodies from STORET are presented in Table 26. The detection limits varied widely, from 0.001 to 2 $\mu g \cdot L^{-1}$. Fifteen out of 1123 samples at 653 sites had detectable levels of azinphos methyl. Note that constitutes less than 2 samples per site. The maximum detection was 3 $\mu g \cdot L^{-1}$.

Table 26. Measurements of azinphos methyl in surface waters in STORET.

	Number of Samples	Number of Detects	Number of Sites	Maximum ($\mu g \cdot L^{-1}$)	Date Range
Canals	289	3	63	0.01	1974-1993
Estuaries	185	2	162	3	1969-1997
Lakes	406	1	242	0.01	1974-1996
Ocean	16	0	6	NA	1980-1985
Reservoirs	91	9	57	0.01	1975-1995
Springs	136	0	123	0.5	1987-1996

NAWQA. The United States Geologic Survey has analyzed for azinphos methyl in up to 40 basins from 1993 to 1997. In an overview based on 5133 samples, there were 164 detections which corresponds to a frequency of detection of 3.2%. The maximum level detected in any sample was 1 $\mu g \cdot L^{-1}$ from a site in the San Joaquin-Tulare Basin. These samples were collected from 760 unique stations in 14 states. States with the largest number of detectable levels were California (69), Washington (27), Pennsylvania (21), and Oregon (5).

In California, the USGS sampled 18 stations in four counties. Half of the stations are in Stanislaus County. Six of the California sites had detections, four sites were classified as 'agricultural indicator' Sites and two were 'integrator' sites.

In Washington, 25 sites were sampled in three counties, three-quarters of the sites were in Pierce and Grant Counties. Six of the sites had detections, three were 'Agricultural Indicator' sites, two were 'Synoptic' sites, and the others were urban sites. In Pennsylvania, the USGS sampled 36 unique stations (P.P. Leahy and T.H. Thompson, 1994).

Unfortunately, the analytical recovery from water samples was 13% for azinphos methyl at concentrations near the detection limit using a multi-residue GC/MS method (USGS National Synthesis Project, 1998b). The method detection limit was 0.001 $\mu g \cdot L^{-1}$. Zaugg *et al.,* 1995 found that recoveries in reagent water were 78% at 0.1 $\mu g \cdot L^{-1}$ and 88% at 1 $\mu g \cdot L^{-1}$. However, in surface water taken from the South Platte River near Henderson, Colorado, the recovery at 0.1 $\mu g \cdot L^{-1}$ was 42% with a relative standard deviation of 14%. At 1 $\mu g \cdot L^{-1}$ the recovery was 23% with a relative standard deviation of 10%. In a groundwater from near Denver, the recoveries were 54 and 52% at 0.1 and 1 $\mu g \cdot L^{-1}$ respectively. The USGS has marked all azinphos methyl with an 'E' for estimated. Consequently, it is inappropriate to draw strong conclusions about the concentrations of azinphos methyl in surface water using these data. If better analytical recoveries were available, detections would be substantially more frequent and the concentrations measured potentially 10 times greater than reported in these studies. These data indicate that azinphos methyl is reaching surface water. However, because the detection frequency and concentrations are inaccurate it does not provide a good quantitative estimate of azinphos methyl in surface water.

Given the limitation in the analytical methods for azinphos methyl, it is still possible to set a lower bound estimate on the concentration of azinphos methyl in water bodies where the pesticide is used. The three NAWQA study units in the first set of 20 study units with the highest azinphos methyl usage have been further analyzed to estimate the concentration that some portion of the population could receive in drinking water. These three study units are the Central Columbia Plateau in Washington, the San Joaquin-Tulare basin in the Central Valley of California, and the Potomac Basin in Maryland, Pennsylvania, Virginia, West Virginia, and the District of Columbia. For each site, the peak monitored value was identified. If there were more than 6 samples taken, the time weighted overall mean was calculated. At these sites, for each year where it was possible, a time-weighted annual mean was also calculated. Where more than one annual mean could be calculated, the greatest annual mean was chosen as the chronic exposure estimate for that site. These are summarized in Appendix IV. The values (for acute and chronic separately) from all three study units were placed in rank order including sites with no detections, and the value nearest to the 95th percentile was chosen as the lower bound for drinking water exposure. Fuller descriptions of each NAWQA unit are included below.

Beyond the analytical difficulties discussed above, there are other difficulties in interpreting this data for drinking water exposure assessment. The sites do not directly reflect water used for drinking water purposes, although most sites would be capable of supporting a drinking water facility. Sites which were obviously inappropriate for drinking water use such as drainage ditches, waste ways, and storm drains were excluded from the assessment. No lakes or reservoirs were included in the sample sites. These water bodies are frequently used to support drinking water facilities. The number of samples collected at each site varied from one up to 100 samples, with only one sample per site frequently being collected. The frequency of sampling varied from several on one day to only one per year. Sampling intervals were usually not equally spaced when multiple samples were taken. This temperal unevenness has at least been partially accounted for by using time-weighted annual means. There are substantial differences in the sampling strategies used in different NAWQA study units. The Potomac River Basin sampling strategy covered a large number of sites (113), most of which were sampled only once. The San Joaquin-Tulare Basin sampled fewer total sites (40) but sampled most sites much more intensively. The likelihood of having a detection at any site increases with the number of samples at each site, so it is not surprising that 22.5% of the sites had detections in the San Joaquin-Tulare Basin versus only 3.5% in the Potomac Basin, although this would also partly be a function of the larger amount of use in the San Joaquin area. Because of the infrequency of the sampling, even at the most intensively monitored sites, it is highly likely that the number of sites with detections and the magnitude of peaks at sites with detections are substantially higher than is estimated here. No attempt has been made to account for these sampling affects on the analysis, so a quantitative interpretation of the exposure values is inappropriate. It should be noted that there were detects. It should also be noted that there are a number of sites in other NAWQA study units that had detects between than 0.1 and $1\ \mu g \cdot L^{-1}$.

Central Columbia Plateau. The Central Columbia Plateau is a prominent apple growing region. Based on 1992, National Agricultural Statistics Service data, this NAWQA unit had the second highest azinphos methyl usage among the 20 NAWQA units initiated in 1991 and eighth among all 60 NAWQA study units. There were 40 sampling sites for surface water on the Central Columbia Plateau with detections at seven of the sites or 17.5% of the sites. Of these, thirteen sites were wasteways, or drainage ways, and thus not suitable for use as a drinking water source. One of these sites had a detection. While the data was tabulated for these sites in Appendix IV, they were excluded from use in the drinking water exposure assessment. Nine of the sites were suitable for estimating chronic risk and three of these sites had detections. The maximum value found in the Central Columbia Plateau was $0.20\ \mu g \cdot L^{-1}$ and the maximum chronic value was $0.026\ \mu g \cdot L^{-1}$.

Potomac Basin. The Potomac Basin is also a prominent apple growing region including the Shenandoah Valley in Virginia and the Cumberland Valley in Pennsylvania. Based on 1992, National Agricultural Statistics Service data, this NAWQA unit had the third highest azinphos methyl usage among the 20 NAWQA units initiated in 1991 and ninth among all 60 NAWQA study units. There were 113 different sites sampled in the Potomac Basin. Four of these sites had at least one detect, or 3.5%. However, 54 of the sites were not in regions where apples, or other orchard crops were grown. This includes all the tributaries and the main stem of the Potomac above the confluence of Conococheague Creek, and all tributaries entering the tidal Potomac. These sites were excluded from the assessment. The remaining 61 sites include Conococheague Creek and its tributaries, the Monocacy River and it tributaries and the Shenandoah River Valley. Two of the sites with detections were near intakes for drinking water facilities. The Monocacy River is used as the source water for the city of Frederick, Maryland and the Potomac River at Chain Bridge is used as the source water for Washington, DC and Arlington, Virginia. Of these sites, 5 were sampled so that time-weighted annual means could be estimated. Two of these five sites had detections, or 40%. It is suspected that if other sites in this portion of the basin were sampled as intensively as these, the overall detection rate by site would be closer to this value than 3.5%. The maximum value in the basin was 0.13 : g C L^{-1} and the maximum chronic value was 0.027 : g C L^{-1}.

San Joaquin-Tulare Basin. The San Joaquin-Tulare Study Unit is used to grow a number of different orchard crops on which azinphos methyl is used. Based on 1992, National Agricultural Statistics Service data, this NAWQA unit had the highest azinphos methyl usage among the 20 NAWQA units initiated in 1991 and was second among all 60 NAWQA study units. There were 40 different sites sampled in the San Joaquin-Tulare Basin. Nine of these sites had at least one detect, or 22.5%. Of these sites, 11 were not appropriate for use in drinking water assessment. This includes four sites with detections. One of these excluded sites, the Spanish Grant Combined Drain near Patterson, California had the highest detect of any NAWQA site, 1 : g C L^{-1}. Of the remaining 29 sites, 5 had detections. The maximum detection among these sites was 0.39 : g C L^{-1}. Eleven of the 40 sites had greater than 6 samples taken and time weighted annual means were estimated for chronic assessments . However, two of these sites were on the excluded list and both had detections. The highest time-weighted annual mean was 0.078 : g C L^{-1}. Some sites in this basin had chronic low levels of contamination. Orestimba Creek had 41 detections out of 100 samples. Turlock Irrigation Lateral No. 5 had 13 detects in 25 samples. It is worth noting that of the 22 sites with only a single sample, only 3 had detections, or 13%. Five of the eleven sites with six or more samples had detects, or 45%, indicating that the detection rate is substantially underestimated at sites with few samples taken.

USGS Toxic Substances Hydrology Program Mississippi Embayment, 1996-1997. The US Geological Survey reported on the occurrence of azinphos methyl in the Mississippi Embayment (Thurman et al., 1998) The written report only includes the 1996 data. (The 1997 data is provided by personal communication with Betty Scribner and Lisa Zimmerman.) There was only 1 detection above 0.05 : g C L^{-1} in 137 samples from 31 sites. The number of samples collected at each site varied from 1 to 31. The single detect was one of eleven samples taken from Steele Bayou. The study area is concurrent with the NAWQA Mississippi Embayment study unit. This basin had the greatest azinphos methyl usage of any study unit according to 1992 NASS data. However, usage in this area has dropped to around 10% of the 1992 levels by 1998. This would at least partially account for the low number of detections found in this location. The infrequent detection level plus an increased detection limit account for the lower detection rate relative to the NAWQA data. Information on the analytical recovery was not available for this data.

South Florida Water Management District. The South Florida Water Management District collected monitoring data from 1988 to 1993 (Miles and Pfeuffer, 1994). Samples were collected from 27 sites. Samples were analyzed for azinphos methyl with a method modified from EPA 614 using gas chromatography with an NP detector. The detection limit for azinphos methyl varied from 0.25 to 9 : g

C L^{-1}. Detection limits generally improved with time during the study. On some samples, it was indicated that the analytical recovery for azinphos methyl was poor. There were no detects in 327 samples. However, it should be noted that there is little use of azinphos methyl in South Florida. Miles and Pfeuffer (1996) estimate only 8 tons of azinphos methyl use in the South Florida Water Management District. All of this was on sugar cane. Note that the use estimate in Figure 1 indicates substantial use in south Florida. This is an artifact of the methodology used to develop the graph. The national average per cent of crop treated was multiplied by the county acreage of each crop. In fact, most of the azinphos methyl applied to sugar cane is in Louisiana, not Florida.

Tier 2 Modeling with PRZM and EXAMS. This analysis is described in detail in Jones, 1998. This document supercedes previous Tier 2 estimates for azinphos methyl for almonds, apples, cherries, cotton, filberts, peaches, plums/prunes, potatoes, and walnuts (D494129, D189494, D189497, D189505, D189508). In addition, EEC's were calculated for sugar cane in Louisiana. Tier 1 EEC's were generated for the same crops described here using 'back of the envelope' technique (D189497, D189505, D189508), but GENEEC was not used as exceedances were already expected due to previous Tier 2 modeling.

A Tier 2 EEC uses a single site which represents a high exposure scenario for the use of the pesticide on a particular crop or non-crop use site. The weather and agricultural practice are simulated using real weather and soils data over multiple (in this case, 20, 34 or 36) years so that the probability of an EEC occurring at that site can be estimated. For deterministic risk assessments, the one in ten year return frequency EEC's of certain specified durations are interpolated from the annual exceedance curve. The durations estimated are intended to reflect the durations of human health and ecological toxicity studies. Since for almonds and plums/prunes, weather was not considered, the EEC's are the same for each year. For these two cases, only four years were run, and the EEC's represent the values in the fourth year.

The maximum application practice for each crop for all the Guthion products were estimated. (Several products have been voluntarily cancelled.) The Guthion products were selected in consultation with the Special Review and Reregistration Division as being suitable for risk management for all azinphos methyl uses. Aerial application was assumed for all uses as this was an allowable practice for all simulated crops. However, the orchard crops are much more likely to receive application by spray blast which usually generates less drift than an aerial application. In addition, when data was available the typical application practice was also simulated. These were included to facilitate possible mitigation. The application practices simulated are in Table 27. When information on the typical application practice was available, a typical application was simulated for use assessing potential risk mitigation. Typical rates were provided by BEAD and represent mean application rate and numbers. For cotton, there was no information on the label regarding the maximum number of applications, or the minimum application interval. Seventeen applications at three day intervals were used. However, the primary registrant, Bayer has submitted label modifications limiting the number of applications to 4 per year.

Several crops had geographic restrictions on the label, mostly distinguishing between practices to use in the eastern and western United States. In most cases, only one practice was simulated. Generally, the eastern practice was simulated as the EEC's were expected to be higher in the eastern United States than in the west due to the much more frequent and intense rainfall. This was the case for peaches, cotton and cherries. Eastern and western apples were both simulated. Pears and plums/prunes were simulated with a western scenario and application practice as more than 90% of these crops were grown in the western coastal states.

For cherries, an alternate row middle application practice was simulated for second application of the typical use pattern. An alternate row middle application has a spray blast application down the center of every other row. A second application to the other row middles is made in seven days. An alternate row middle application was also made to peaches in addition to the regular application practice at the typical application rate. Alternate row middle application was simulated by applying half the application rate twice, seven days apart.

Products	Single Application Rate	Maximum Number of Applications	Application Interval	Harvest Interval	First Application Date
Table 27. Application scenarios modeled for azinphos methyl with PRZM and EXAMS					
Almonds					
50% WP's,	2.0	3	120, 28*	28	January 5
35% WP's	2.0	2	30	60	April 5
typical	1.4	2	30	NA	April 5
Apples					
Guthion WP's	1.5	4	7	7	May 1
typical, eastern	0.65	4	7	NA	May 1
typical, western	0.65	4	7	NA	May 1
Cherries					
Guthion WP's	0.75	2	14	15	April 1
typical	0.75	2[‡]	14	NA	April 1
Cotton					
Guthion 3F**	0.5	17[†]	3		June 6
Guthion 3F, ** 6 apps.	0.5	6	3		June 6
typical	0.3	2	7	NA	June 6
Filberts					
all Guthions	2.0	3	14	30	June 15
Peaches					
All Guthions	2	4	14	21	March 21
typical	0.6	3[‡]	14	NA	March 21
Pears					
Guthion WP's	1.5	4	7	7	May 1
typical	1.0	3	7, 60	NA	May 1

Table 27 continued.

Products	Single Application	Maximum Number of	Application Interval	Harvest Interval	First Application

Plums/Prunes					
all Guthions	2.0	2§	10	15	April 1
typical	0.9	1	NA	NA	April 1
Sugar Cane					
Guthion 3F**	0.74	2	21	NA	July 1
Walnuts					
all Guthions	2	3	14	21	July 15
typical	1.3	1	NA	NA	July 15

* First application is dormant application
**Product has been voluntarily canceled
† No actual limit on the label
‡ 1 regular application and one alternate row middle application
§1 application of 2.0 and a second application of 1.375 lb $acre^{-1}$

The EEC's were estimated using PRZM version 2.3 and EXAMS version 2.94. The PRZM 2 simulation was run for a period of 20, 34, or 36 years depending on the amount of available weather data with the scenario. An application efficiency of 75% and a spray drift loading of 5% of the application rate were used to represent an aerial application to each crop. Aerial application was simulated as it is allowed on the label for all the crops assessed. The yearly maximums, largest yearly 96-hour means, and largest yearly 21-day means were extracted from EXAMS output by EXAMS by PEO. The largest 60-day, 90-day, and annual means were calculated by PEO from daily concentration data contained in EXAMS plot data listings. The 10 year return EEC's (or 10% yearly exceedance EEC's) were calculated by linear interpolation by PEO.

The level of risk associated with Tier 2 modeling is primarily controlled through selection of the scenario. Scenarios were chosen to represent a site that produces more runoff than 90% of the sites that are used for that crop. Site selection is currently done by best professional judgement. Seven sites were used to model the crops considered in this analysis. The almond scenario was in Kern County, California. Only the pond was used as only spray drift was considered. Runoff is a negligible source of loading compared to spray drift in the Central Valley of California. The eastern apple scenario was an orchard in Columbia County, New York in MLRA (major land resource area)144B. The soil at the site is similar in properties to a Sharkey clay soil, a very-fine, montmorillonitic, non-acid, thermic Vertic Haplaquept. Note that the Sharkey clay is generally considered to a soil of the lower Mississippi Valley, not the Hudson River Valley. The Sharkey clay soil properties were used as a surrogate to represent the New York soil in this scenario. Western apples, filberts, pears and walnuts were simulated at a site in Washington County, Oregon in the Hood River Valley. This is in MLRA 2. The soil at the site was a Cornelius silt loam, a fine-silty, mixed, mesic Ultic Haploxeralf on a 15% slope. This site was selected as a general high exposure scenario for orchard crops in the Northwest. The cherry scenario is an orchard in Grand Traverse County, Michigan in MLRA L96. The soil at the site was a Kewaunee silt loam, a fine, mixed, mesic Typic Hapludalf. The cotton field is in Yazoo County, Mississippi. It has a Loring silt loam soil, a fine-silty, mixed, mesic Thermic Typic Fragiudalf, in MLRA O-134. The peach orchard is in Peach County, Georgia. It has a Boswell sandy loam soil, a fine, mixed, thermic Vertic Paleudalf, in MLRA P133A. The Boswell soil is hydrologic group C soil and SCS curve numbers were generated based on this grouping and the plant cover as above. The plum and prune site was a plum orchard in Tulare County, California in MLRA C17. Only spray drift was modeled at this site because of the small amount of open surface water in this area and the paucity of rain during the growing season. As with almonds only the pond was simulated for plums and prunes. The potato scenario was in Aroostook County, Maine in MLRA R143. It has a Conant silt loam soil, a fine-loamy, mixed, frigid Aquic Haplorthod. Conant soils are moderately well drained to somewhat poorly drained and has been treated as a Group C soil in this scenario. The sugar cane scenario was in Saint Martin's Parish, Louisiana in MLRA O131. The soil was a Sharkey clay a very-fine, montmorillonitic, non-acid, thermic Vertic Haplaquept.

The ponds used are modified for generic use from the Richard Lee pond that is distributed with EXAMS and is the standard pond used for all EEC calculations. Modifications were made to convert the pond from 1 acre, 6 ft deep to 1 ha, 2 m deep. Additionally, adjustments were made to the standard pond by changing the water temperature to that which was more appropriate for the region being simulated. The temperature in the pond each month was set to the average monthly air temperature over all 36 years calculated from the meteorological file that was used in the simulation.

The environmental fate data that was used to generate the chemistry input parameters to PRZM and EXAMS are in Table28. The PRZM chemistry parameters are in Table 29 and the EXAMS chemistry parameters are in Table 30. A complete description of how the chemistry input parameters were estimated from the fate data is in Jones, 1998. Note that the PRZM soil water partition parameter, KD, is based on the desorption rather than the adsorption coefficient as is current policy. The parameter selection was based on an older policy. The resulting differences in the EEC's are slight.

Table 28. Environmental fate parameters for azinphos methyl.

Fate Parameter	Value	Source
Molecular Mass	$317.32\ g \cdot mol^{-1}$	EFGWB One-Liner
Aerobic Soil Metabolism Rate Constant	$2.17 \times 10^{-2}\ d^{-1}$	Gronberg *et al., 1979*
Anaerobic Soil Metabolism Rate Constant	$1.04 \times 10^{-2}\ d^{-1}$	Gronberg *et al.*, 1979
K_{des}	$8.414\ L \cdot kg\text{-}soil^{-1}$	Lenz, 1979
K_{ads}	$7.55\ L \cdot kg\text{-}soil^{-1}$	Lenz, 1979
Solubility	$25.10\ mg \cdot L^{-1}$	EFGWB One-Liner
Vapor Pressure	2.2×10^{-7} torr	EFGWB One-Liner
Acidic Hydrolysis Rate Constant	$4.78\ L \cdot (mol\text{-}H^{+})^{-1} \cdot d^{-1}$	EFGWB One-Liner
Neutral Hydrolysis Constant	$7.83 \times 10^{-4}\ d^{-1}$	Wilkes *et al., 1979*
Alkaline Hydrolysis Constant	$82\ L \cdot (mol\text{-}OH^{+})^{-1} \cdot d^{-1}$	Wilkes *et al., 1979*
Aqueous Photolysis Constant	$2.17 \times 10^{-1}\ d^{-1}$	EFGWB One-Liner
Washoff Fraction	0.937	Gunther *et al*., 1977
Foliar Degradation Rate Constant	$7.2 \times 10^{-2}\ d^{-1}$	see fate assessment

Table 29. PRZM 2.3 input parameters for azinphos methyl.		
Input Parameter	Value	Quality
Foliar Volatilization (PLVKRT)	0 d^{-1}	poor
Foliar Decay Rate (PLDKRT)	7.0×10^{-2} d^{-1}	good
Foliar Washoff Extraction Coefficient (FEXTRC)	0.937 cm^{-1}	fair
Plant Uptake Fraction (UPTKF)	0	poor
Soil-Water Partition Coefficient (KD)	8.414 L @kg-$soil^{-1}$	good
Dissolved Phase Decay Rate: A Horizon (DWRATE)	7.25×10^{-3} d^{-1}	fair
Adsorbed Phase Decay Rate: A Horizon (DSRATE)	7.25×10^{-3} d^{-1}	fair
Dissolved Phase Decay Rate: Lower Horizons (DWRATE)	3.44×10^{-3} d^{-1}	fair
Adsorbed Phase Decay Rate: Lower Horizons (DSRATE)	3.44×10^{-3} d^{-1}	poor
Vapor Phase Decay Rate (DGRATE)	0 d^{-1}	poor

Table 30. EXAMS 2.0 Input parameters for azinphos methyl.		
Input Parameter	Value	Quality
Aerobic Aqueous Metabolism Constant (KBACW)	$1.02x10^{-4}$ h^{-1}	poor
Sediment Metabolism Constant (KBACS)	$9.56x10^{-5}$ h^{-1}	poor
Acidic Hydrolysis Rate Constant (KAH)	0 L$\cdot$(mol-H^{+})$^{-1}$ $\cdot h^{-1}$	good
Neutral Hydrolysis Entropy Factor (KNH)	$4.33x10^{4}$ h^{-1}	excellent
Neutral Hydrolysis Activation Energy (ENH)	10.595 kcal $\cdot mol^{-1}$	excellent
Alkaline Hydrolysis Rate Constant (KBH)	$1.85x10^{13}$ L$\cdot$(mol-OH^{-})-1 $\cdot h^{-1}$	excellent
Alkaline Hydrolysis Activation Energy (EBH)	14.6 kcal $\cdot mol^{-1}$	excellent
Photolysis Rate Constant (KDP)	$9.04x10^{-3}$ h^{-1}	good
Partition Coefficient (KPS)	7.55 L $\cdot kg^{-1}$	fair
Molecular Mass (MWT)	317.32 g $\cdot mol^{-1}$	excellent
Solubility (SOL)	25.10 mg$\cdot$ L^{-1}	good
Vapor Pressure (VAPR)	$2.2x10^{-7}$ torr	good
Q10 For The water Column (QTBAW)	2	poor
Q10 For Sediment (QTBAS)	2	poor

There are several factors which limit the accuracy and precision of the Tier 2 analysis including, but not limited to, the selection of the high exposure scenarios, the quality of the input data, the ability of the models to represent the real world, and the number of years that were modeled. There are additional limitations on the use of these numbers as an estimate of drinking water exposure.

It is worth noting again that there is often substantial discrepancies between the typical use pattern for a crop and the maximum label rate. Modeling the maximum use pattern is defendable as these patterns can be used and in fact have been used in some cases in the past with fairly catastrophic results for the local aquatic fauna (see the discussion of incidents data below).

Scenarios that are selected for use in Tier 2 EEC calculations are ones that are likely to produce large concentrations in the aquatic environment. The scenario should represent a site that really exists, is a use allowed by the label, and would be likely to have the pesticide in question applied to it. It should be extreme enough to provide conservative estimates of the EEC, but not so extreme that the model cannot properly simulate the fate and transport processes at the site. Currently, sites are chosen by best professional judgement to represent sites which generally produce EEC's larger than 90% of all sites use for that crop. The EEC's in this analysis are accurate only to the extent that the site represents this hypothetical high exposure site. The most limiting part of the site selection is the use of the standard pond with no outlet. Obviously, a Georgia pond, even with an appropriately modified temperature profile, is not the most appropriate water body for use in Mississippi. It should be remembered that while the standard pond would be expected to generate lower EEC's than most water bodies, some water bodies would likely have higher concentrations. Examples of these would be shallow water bodies near agricultural fields that receive most of their water as runoff from agricultural fields.

The quality of the analysis is directly related to the quality of the input parameters. In general, the fate data for azinphos methyl is good. In particular, azinphos methyl has usable foliar washoff and degradation data which is not usually available. Additional metabolism data would greatly increase our confidence, and likely reduce our EEC estimates.

The models themselves represent a limitation on the analysis quality. While the models are some of the best environmental fate and transport estimation tools available, they have significant limitations in their ability to represent some processes. Spray drift is estimated as a straight 5% of the application rate reaching the pond for each aerial application. In actuality, this value would be expected to vary considerably with each application. A second major limitation of the models is the lack of validation at the field level for pesticide runoff. While several of the algorithms (volume of runoff water, eroded sediment mass) are well validated and well understood, no adequate validation has yet been made of PRZM 2.3 for the amount of pesticide transported in runoff events. An industry group, the FIFRA Environmental Modeling Task Force is currently in the process of validating PRZM. Other limitations of the models are the inability to handle within site variation (spatial variability), very limited crop growth algorithms, and an overly simple soil-water transport algorithm (the "tipping bucket" method).

EXAMS is primarily limited because it is a steady-state model and cannot accurately characterize the dynamic nature of water flow. A model with dynamic hydrology can more accurately reflect the changes in concentration due pond overflow and evaporation.

Another limitation is that only limited amounts of weather data were available for the analysis at each site. Uncommon events such as the 1 in 10 year concentration used for ecological risk assessment require substantial weather data sets in order to have reasonable certainty of their true. For these simulations, 36 years of data is required to ensure that the 10% annual exceedance concentration is bounded by the maximum annual exceedance value with 95% confidence. If the number of years of weather data could be increased, it would increase the confidence that the estimated value for the 10% annual exceedance EEC was close to the true value.

An additional set of limitations is imposed when Tier 2 EEC's are used for drinking water exposure estimates. Obviously, a single 10 hectare field with a 1 hectare pond does not accurately reflect the dynamics in a watershed which is large enough to support a drinking water facility. A basin of this size would certainly not be planted completely to a single crop nor be completely treated with a pesticide. Additionally, treatments with the pesticide would likely occur on different days on different fields. This would reduce the magnitude of the concentration peaks, but also make them broader, reducing the acute exposure, but perhaps increasing the chronic exposure. The fact that the simulated pond has no outlet is also a limitation, as water bodies in this size range would be have at least some flow through (rivers) or turnover (reservoirs). In spite of these limitations, a Tier 2 EEC can provide a reasonable upper bound on the concentration found in drinking water if not an accurate assessment of the real concentration. Risk assessment using Tier 2 values can capably be used as refined screens to demonstrate that the risk is below the level of concern.

Study Summaries

Almonds. An unsolicited study was submitted which was provided supplemental information on potential exposure from azinphos methyl on almonds (MRID 436498-01). The great majority of almonds are grown in the Central Valley of California. The study consisted of two parts, Tier 2 modeling and GIS modeling. Tier 2 modeling was done on a typical site (a Kimberlina silt loam using best estimates of the fate parameters for azinphos methyl. The results were similar to those estimated by the Agency. The one in ten year annual peak in the study was 7.5 :g C L^{-1} whereas the Agency value was 8.3 :g C L^{-1}. The values are similar because the EEC is dominated by spray drift which was estimated by the same method in both cases. The GIS component of the study was used to estimate the proximity of almond orchards to water bodies. The assessment was done for Kern County California as surrogate for all the almond growing regions in California. Very little naturally flowing water is found in Kern County. Most of the flowing water consist of irrigation canals. Only 1.1% of almond orchards were found to have standing water within 400 ft of the orchard. The registrant (Bayer) proposed mitigation measures in the study. These were a 25 ft buffer to mitigate spray drift and the elimination of the dormant spray to eliminate most of the little runoff that occurs. Some limited spray drift data was provided to support the buffer strip, but no analysis of the data was made to determine the change in exposure associated with the recommended buffer width. In addition, this data was produced by the spray drift task force and has not yet been accepted for use in risk assessments.

Apples. A number of studies were submitted bearing on the aquatic exposure associated with apples. A GIS study by Crabtree *et al.*, 1997 (MRID 444118-03) focused on the proximity of apples to aquatic habitat in three locations, Washington, Michigan and New York. A watershed based modeling approach using the SWAT model was also submitted (MRID 444118-04). However, the results of this study more directly reflect the adequacy of the SWAT model than of the exposure of azinphos methyl and is not further discussed here. An overall summary by Dobbs, 1997 (MRID 442665-01) of these efforts was provided as well.

The GIS study identified three apple growing regions that appeared more vulnerable than most regions to pesticide contamination of surface water. These regions were in the area of Brewster and Lake Chelan in Washington, west-central Michigan near Lake Michigan, and eastern Ulster County in New York. The registrant concluded that apples are rarely found directly adjacent to surface water with less than 1% in Washington, 1.4% in Michigan and 1.6% in New York. “Directly adjacent” was apparently defined as having the orchard trees within 10 meters of the water body, which was the limit of resolution for the GIS techniques employed. For Washington, 3% of the land area was in apple orchards and 55% of the total apple acreage was within 400 m of flowing water. An additional 5% of the total apple acreage was within 400 m of a static water body. In Michigan, 2% of the region studied was in apple orchards. Twenty-eight per cent of the apple acreage was within 400 m of intermittent streams, 8% within 400 m of lakes or ponds, 6% within 400 m of rivers and streams and 2% within 400 m of wetlands. For New York, 43% of apple acreage was within 400 m of rivers and streams, 6% for lakes and ponds, and 1% for wetlands. This study indicates that while there is at least a field border between most apple orchards and aquatic habitat, there are substantial acreage of apples with a short distance of large portions of apples nationwide.

The various projects undertaken by Bayer to support the apple use of azinphos methyl were summarized by Dobbs, 1997. This summary included a discussion of the GIS study above, Tier 2 modeling efforts, watershed modeling efforts, and a summary of results from the STORET data base. The tier 2 modeling results (MRID 444118-02) were based on best estimates of the fate parameters and the standard sites used by the Agency. The Michigan site was similar to the site used by the Agency for cherries. The results were similar to those produced by the Agency. The monitoring data presented here is included in the data discussed in the STORET section above.

Ground Water

Since azinphos methyl is only moderately mobile to leaching and since it degrades by hydrolysis, it is not expected to be reach ground water under most conditions. The exception to this may be in karst areas or where preferential flow is the dominant transport mechanism. When it does reach groundwater, it is not expected to persist. There are a limited number of detections of azinphos methyl in ground water as described below. An estimate of the concentration that might be in ground water under highly vulnerable conditions was made with SCI-GROW (Barrett, 1997). A input parameter for K_{oc} of 579 L kg^{-1} was estimated from the batch equilibria data . This represents the median K_{oc} in accord with current SCI-GROW documentation. Note that K_{oc} was not found to be valid description of binding for azinphos methyl. (See Fate Assessment above.) The best estimate half-life from the aerobic soil metabolism study of 32 d was used for the half-life parameter. A list of SCI-Grow estimates for a variety of different crops and application practices are listed in Table 31. The single SCI-Grow estimate provided for drinking water exposure assessment was that from the eastern cotton use pattern. This value was chosen over the higher western cotton use pattern value because mitigating factors not considered by SCI-GROW likely make the eastern cotton value a better reflection of the actual upper bound concentrations of azinphos methyl in ground water. These mitigating factors include substantially less precipitation and generally higher soil pH's in the western cotton growing regions.

Table 31. SCI-GROW estimates for azinphos methyl use in vulnerable groundwater for various crops.

Crop	Annual Maximum Total Application (lb acre^{-1})	Ground water Concentration (µg·L^{-1})
Almond, Apples, Filberts, Pears, Walnuts	6 lb acre^{-1}	0.40
Cherries	3	0.20
Peaches, Potatoes	4.5	0.31
Plums/Prunes	3.38	0.23
Cotton	6.4 (eastern)	0.44
Cotton	12.8 (western)	0.85

There is monitoring data on azinphos methyl from three different sources. In STORET, there were no detections of azinphos methyl in 3882 samples collected at 3247 sites from 1975 to 1997. Detection limits ranged from 0.003 to 300 µg·L^{-1}. Azinphos methyl was not included among the analytes for the National Pesticide Survey (USEPA, 1990). Short discussions of data in the Pesticides in Ground Water Database and NAWQA are provided below.

Pesticides in Ground Water Database. There were 1598 wells sampled in 9 states, California, Indiana, Georgia, Hawaii, Maine, New York, Oklahoma, Rhode Island and Texas, with no detections in the EPA's Pesticides In Ground Water Database (Hoheisel *et al.*, 1992) However, there are 16 detections of azinphos methyl listed for the state of Virginia[2]. All the detections were in Virginia from 60 samples collected in July and August of 1987 in Clarke and Frederick County in the Shenandoah Valley (Goodell, 1987). Sixty wells were sampled with a single sample each. Samples were analyzed by gas chromatography with an E detector. There is no indication that a confirmatory method was used. No detection limit was provided. Clark County is dominantly in pasture and field crop agriculture with 6% of the county in orchards. Frederick County is the top county for production of both peaches and apples in Virginia, with 9000 acres of orchards. There were 12 detections in Clarke County and 4 detections in Frederick County. According to Goodell, the concentration "often exceeds 75 µg·L^{-1}". No other indication of the concentrations actually measured is given. The concentration of azinphos methyl listed was greater than any other pesticide in the study except 2,4-D, which was greater than

[2] The PGWDB National summary incorrectly lists 5 detects in 30 samples. The PGWDB Region 3 Summary incorrectly lists 30 total wells, 432 total samples and one detect greater than the MCL and 5 below the MCL.

100 µg·L^{-1}. Other pesticides monitored included methyl parathion, and endosulfan and 2,4,5-TP. Of the sixteen detects, 9 were associated with orchards, 5 with "agriculture", and 2 with "other". There was indication of the distribution of the non-detects among these use sites. Goodell characterized the underlying aquifer as either carbonatic, shale, or other. Ninety-three of 120 total pesticide detections in the 60 samples were associated with carbonatic aquifer. This aquifer is associated with the karst topography and consequently the ground water is highly vulnerable. However, because carbonate aquifers are normally high in pH and because azinphos methyl degrades rather quickly under these conditions, azinphos methyl is not expected to persist in these aquifers. This data set has some significant uncertainties associated with it. However, the concentrations reported are reason for substantial concern.

Karst topography is associated with land form features such as caves and sinkholes. Karst is found throughout the U.S., including areas of Florida, Kentucky, Pennsylvania, Missouri, Iowa, New Mexico, and Virginia. There are strong connections between surface water and ground water in karst regions. While the QA/QC information that are necessary to assure that the monitoring data is of high quality are not available and the data are described in less detail than is desirable in the Virginia data, we have no reason to doubt their validity. Because recharge of groundwater is very rapid in karst topography, the results of the study are plausible and are cause for substantial concern. This concern extends beyond the two counties that were sampled in this study to other karst regions where azinphos methyl is used. The SCI-GROW model estimates (described below) are not representative of karst hydrology, but rather represent shallow ground water under sandy soils in area with substantial recharge. Thus, while SCI-GROW represents a good screening estimate on what would be expected in most ground water, it does not provide a good screening estimate for ground water in karst terrain. As noted above, karst aquifers will have a high pH and azinphos methyl is not expected to persist under these conditions. Consequently our concern is for acute risk rather than chronic risk. Because of the QA/QC concerns and the lack of detail in the data description, these data by themselves are not sufficiently reliable to support strong regulatory action if they trigger risk concerns. They are however, sufficient to warrant additional monitoring in karst regions in order to better characterized azinphos methyl occurrence in these aquifer systems.

NAWQA. Data from the NAWQA program (USGS National Synthesis Project, 1998) found four detections of azinphos methyl ranging from 0.003 to 0.064 µg·L^{-1}. The detection limit varied from 0.001 to 0.15 µg·L^{-1}. It was 0.001 µg·L^{-1} for about 95% of the data. Three of the detections were in Grant and Adams Counties in Washington. Two of these detections (0.014 and 0.064 µg·L^{-1}) were in public drinking water supplies. The third detection of 0.018 µg·L^{-1} was in an unused well. The fourth detection was in an unused well in Richland County, North Dakota at 0.003 µg·L^{-1}. Note however that the analytical recovery for azinphos methyl was only 13% (USGS National Synthesis Project, 1998b).

3. Ecological Effects Hazard Assessment

a. Toxicity to Terrestrial Animals

i. Birds, Acute and Subacute

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of azinphos methyl to birds. The preferred test species is either the mallard (waterfowl species) or the northern bobwhite (upland gamebird species). Results of this test are tabulated below.

Table 32. Avian Acute Oral Toxicity

Species	% ai	LD50 (mg/kg)	Toxicity Category	MRID No. Author/Year	Study Classification[1]
Northern bobwhite *(Colinus virginianus)*	88.8	32	highly toxic	402548-01 Stubblefield 1987	core
Northern bobwhite	tech.	33	highly toxic	406058-01 Grimes and Jabar 1988	supplemental[2]
Northern bobwhite	90	60	moderately toxic	00160000 Hudson et al. 1984	supplemental[2]
Mallard *(Anas platyrhynchos)*	90	136	moderately toxic	00160000 Hudson et al. 1984	supplemental[2]
Ring-necked pheasant *(Phasianus colchicus)*	90	74.9	moderately toxic	00160000 Hudson et al. 1984	supplemental[2]
Ring-necked pheasant	form.	283	moderately toxic	00160000 Hudson et al. 1984	supplemental[2]
Chukar *(Alectoris chukar)*	90	84.2	moderately toxic	00160000 Hudson et al. 1984	supplemental[2,3]

[1] core study satisfies guideline; supplemental study is scientifically sound but does not satisfy guideline
[2] test conditions were not reported in sufficient detail
[3] not a recommended guideline test species

Because the lowest LD50 (32 mg/kg, northern bobwhite) is between10 to 50 mg/kg, azinphos methyl is categorized as highly toxic to birds on an acute oral basis. Based on an LD50 of 283 mg/kg, a formulated product (unspecified % ai) is categorized as moderately toxic. The guideline (71-1) is fulfilled (MRID 402548-01, 406058-01, 00160000).

Two subacute dietary studies using the TGAI also are required to establish the toxicity of azinphos methyl to birds. The preferred test species are the mallard and northern bobwhite. Results of these tests are tabulated below.

Table 33. Avian Subacute Dietary Toxicity					
Species	% ai	5-Day LC50 (ppm)[1]	Toxicity Category	MRID No. Author/Year	Study Classification
Northern bobwhite *(Colinus virginianus)*	92	488	highly toxic	00022923 Hill et al. 1975	core
Mallard *(Anas platyrhynchos)*	92	1940	slightly toxic	00022923 Hill et al. 1975	core
Ring-necked pheasant *(Phasianus colchicus)*	92	1821	slightly toxic	00022923 Hill et al. 1975	core
Japanese quail *(Coturnix coturnix japonica)*	92	639	moderately toxic	00022923 Hill et al. 1975	supplemental[2]

[1] test organisms observed an additional three days while on untreated feed
[2] not a recommended guideline test species

Because the lowest LC50 (488 ppm, northern bobwhite) is in the range of 50 - 500 ppm, azinphos methyl is categorized as highly toxic to avian species on a subacute dietary basis. The guideline (71-2) is fulfilled (MRID 00022923).

ii. Birds, Chronic

Avian reproduction studies using the TGAI are currently required for all pesticides having outdoor uses. The preferred test species are the mallard and northern bobwhite. Results of these tests are tabulated below.

Table 34. Avian Reproduction						
Species	% ai	NOAEC (ppm)	LOEC (ppm)	Affected Endpoints	MRID No. Author/Year	Study Classification
Northern bobwhite *(Colinus virginianus)*	88.8	15.6	87.4	eggs laid, viable embryos, 14-day-old survivors	410561-01 Beavers et al. 1988	core
Mallard *(Anas platyrhynchos)*	88.8	10.5	32.5	& weight gain	408442-01 Toll 1988 and 412187-01[1] Grace and Toll 1989	core

[1] additional information to upgrade MRID No. 408442-01

Based on the mallard, the most sensitive species, an avian chronic NOAEC is established at 10.5 ppm due to adverse effects on adult hen weight gain at a dietary dosage of 32.5 ppm. At 87.4

ppm, significant adverse reproductive effects were observed in the northern bobwhite. The guideline (71-4) is fulfilled (MRID 408442-01, 410561-01).

iii. Mammals, Acute and Subacute

Wild mammal testing is required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern and pertinent environmental fate characteristics. For most pesticides, rat or mouse toxicity values obtained from studies submitted to the Agency's Health Effects Division are used in lieu of wild mammal testing. For azinphos methyl, however, one subacute dietary study with deer mice was submitted and additional data were available from a published study accepted as supplemental data. These toxicity values are tabulated separately below for acute oral, subacute dietary, and chronic reproductive studies.

Table 35. Mammalian Acute Oral Toxicity

Species	% ai	LD50 (mg/kg)	Toxicity Category	MRID No. or Author/Year	Study Classification
Laboratory rat *(Rattus norvegicus)*	85	7.8	very highly toxic	402801-01	core
Laboratory mouse *(Mus musculus)*	99.1	11	highly toxic	Meyers and Wolff 1994[1]	supplemental
House mouse (wild) *(Mus musculus)*	99.1	10	highly toxic	Meyers and Wolff 1994	supplemental
Gray-tailed vole *(Microtus canicaudus)*	99.1	32	highly toxic	Meyers and Wolff 1994	supplemental
Deer mouse *(Peromyscus maniculatus)*	99.1	48	highly toxic	Meyers and Wolff 1994	supplemental

[1] Arch. Environ. Contam. Toxicol. 26:478-482

Because the lowest LD50 (7.8 mg/kg, laboratory rat) is <10 mg/kg, azinphos methyl is categorized as very highly toxic to small mammals on an acute oral basis.

Table 36. Mammalian Subacute Dietary Toxicity					
Species	% ai	5-Day LC50 (ppm)	Toxicity Category	MRID No. or Author/Year	Study Classification
Laboratory mouse *(Mus musculus)*	99.1	543	moderately toxic	Meyers and Wolff 1994[1]	supplemental
Gray-tailed vole *(Microtus canicaudus)*	99.1	406	highly toxic	Meyers and Wolff 1994[1]	supplemental
Deer mouse *(Peromyscus maniculatus)*	99.1	2425	slightly toxic	Meyers and Wolff 1994[1]	supplemental
Deer mouse	92	>5000[2]	practically nontoxic	408583-01	supplemental[3]

[1] Arch. Environ. Contam. Toxicol. 26:478-482
[2] 4/10 individuals died at 5000 ppm
[3] dietary concentrations fed to the deer mice were not confirmed

The lowest LC50 (406 ppm, gray-tailed vole) falls in the range of 50 - 500 ppm, which categorizes azinphos methyl as highly toxic to small mammals on a subacute dietary basis.

Table 37. Mammalian Reproduction						
Species	% ai	NOAEC (ppm)	LOEC (ppm)	Endpoints Affected	MRID No.	Study Classification
Laboratory rat *(Rattus norvegicus)*	87.2	5	15	pup mortality, viability, lactation, litter weight	403326-01	core

Based on a two-generation reproduction test with the laboratory rat, the mammalian NOAEC is established at 5 ppm.

iv. Insects

A honey bee acute contact study using the TGAI is required for azinphos methyl because its use on a variety of agricultural crops may result in honey bee exposure. Results of this test are tabulated below.

Table 38. Beneficial Insect Toxicity						
Species	% ai	Type of Study	Results	Toxicity Category	MRID No. Author/Year	Study Classification
Honey bee *(Apis mellifera)*	tech.	acute oral (48-h LD50)	LD50 = 0.15 µg/bee	highly toxic	05004151 Stephenson 1968	core
Honey bee	tech.	acute contact (48-h LD50)	LD50 = 0.063 µg/bee	highly toxic	05004151 Stephenson 1968	core
Honey bee	tech.	acute contact (48-h LD50)	LD50 = 0.423 µg/bee	highly toxic	00066220 Atkins et al. 1976	core
Honey bee (worker bees)	50 WP	foliar residue (3 lb ai/A)	residues highly toxic for 4-13 days after application	n/a	404663-01 Schmidt 1987	core

The oral and contact LD50s of <2 : g/bee categorize azinphos methyl as highly toxic to honey bees. Guthion 50 WP applied at 3 lb ai/acre on alfalfa foliage and exposed to caged bees demonstrated that residues on treated foliage may remain toxic to honey bees for several days after application. When treatment was followed by a period of fair, dry weather, 100% of the bees were killed through day 13. When dried residue was subjected to showers or light precipitation, mortality occurred for 4 and 11 days, respectively. The guideline requirements for acute contact (141-1) and toxicity of residues on foliage (141-2) are fulfilled (MRID 05004151, 00066220, 404663-01).

Although not required, data on the toxicity of 25% and 50% WP formulations to nontarget soil and surface insects and mites have been submitted and reviewed. Results of studies determined to be scientifically sound are tabulated below:

Table 39. Soil and Surface Insect and Mite Toxicity			
Species	% ai	Results	MRID No. Author/Year
Parasitic wasp *(Aphytis melinus)*	50 WP	high toxicity to adults, but not juveniles, when applied at 380 ppm on lemons	05004003 Davies and McLaren 1977
Predaceous beetles (2 spp.), Parasitic wasps (2 spp.)	25 WP	>50% toxicity to insects exposed to 0.0477% ai in honey bait	05005640 Bartlett 1966
Predaceous beetles (6 spp.) Predaceous wasps (5 spp.)	25 WP	>50% toxicity to all species exposed to dry residue (24 h postappl.) on wax paper sprayed with guthion at 0.5 lb ai/100 gal	05003978 Bartlett 1963
Predaceous mite *(Amblyseius hibisci)*	25 WP	highly toxic at 0.5 lb ai/100 gal	05004148 Bartlett 1964

These results indicate that azinphos methyl is highly toxic to soil and surface insects and mites.

v. Terrestrial Field and Pen Tests

Field studies conducted in apple orchards in Washington (Johnson et al. 1989, MRID 411397-01) and Michigan (Sheeley et al. 1989, MRID 411959-01) demonstrated that some birds and small mammals are likely to be poisoned from spray applications of azinphos methyl. In Washington, eight orchards were treated with three 1.5 lb ai/acre applications (Guthion 35% WP applied with airblast sprayers) at 7- to 11-day intervals. Eight orchards in Michigan were treated with four 1.5 lb ai/acre applications at 7-to 10-day intervals. The purpose of the studies was to evaluate potential hazards to wildlife based on mortality, population changes of species present in and around the orchards, and from residue levels on foliage and invertebrates. Effects on wildlife were determined from carcass searches pre- and post-treatment, bird censuses based on line transects, and live-trapping of small mammals. Residues were sampled on apple tree foliage, noncrop foliage within and adjacent to orchards, and on a few invertebrates collected within the orchards.

Two casualties were recorded pre-treatment and 27 post-treatment in the eight Michigan orchards. Of the 27 post-treatment mortalities (tabulated below), 14 were considered highly likely to have been treatment related, six were possibly treatment related, and seven were not treatment related. Most carcasses were found within the orchards (38%) or along their perimeter (45%), but 17% were located in adjacent areas outside the orchards.

Table 40. Presumed and Suspected Treatment-related Mortalities and Casualties During Field Tests in Apple Orchards		
Species	Presumed[1]	Suspected[2]
MICHIGAN		
Birds:		
Indigo bunting (*Passerina cyanea*)	1	
Chipping sparrow (*Spizella passerina*)	1	
Killdeer (*Charadrius vociferus*)		1
Unidentified nestling		1
Mammals:		
Northern short-tailed shrew (*Blarina*	4	
brevicauda)	3	
Deer mouse (*Peromyscus maniculatus*)	2	
Meadow vole (*Microtus pennsylvanicus*)	1	
Meadow jumping mouse (*Zapus hudsonius*)	1	
Bat		1
Eastern chipmunk (*Tamias striatus*)		1
Cottontail rabbit (*Sylvilagus* sp.)		2
Unidentified mammal		
WASHINGTON		
Birds:		
Robin (*Turdus migratorius*)	4	
Meadowlark (*Sturnella neglecta*)	1	
American goldfinch (*Carduelis tristis*)	1	
Chipping sparrow (*Spizella passerina*)	1	
Starling (*Sturnus vulgaris*)	1	
California quail (*Callipepla californica*)		10
Ring-necked pheasant (*Phasianus colchicus*)		1
Black-billed magpie (*Pica pica*)		2
Pigeon (*Columba livia*)		1
Unidentified birds		7
Mammals:		
Meadow vole (*Microtus pennsylvanicus*)	12	
Pocket gopher	1	
Ground squirrel		1
Mountain cottontail (*Sylvilagus* sp.)		1
Muskrat (*Ondatra zibethicus*)		1
Mouse		1
Unidentified mammals		9

[1] azinphos methyl residue detected in carcasses, or impaired animal observed with symptoms typical of cholinesterase poisoning
[2] intoxication suspected based on locations of scavenged carcasses or feather or fur spots and when found in relation to treatment times

In the Washington study, 173 casualties were recorded, including 59 birds of 14 species, 109 mammals of seven species, and five reptiles of two species. Of these, 162 (94%) were found after treatments began. American robins and California quail accounted for 34% and 20%, respectively, of the total avian casualties. Meadow voles comprised 82% of the mammalian casualties. Only 40 of the

173 casualties were analyzed for tissue residue, and 21 (53%) were considered treatment related based on the detection of residue in carcasses. Additionally, 117 other casualties might have been treatment related, based on the circumstances and/or time frames under which carcasses were found. Only 35 casualties were definitely not treatment related. Of the carcasses recovered, 46% were found along orchard perimeters, 41% in orchard interiors, and 13% in areas adjacent to the orchards.

The effects of azinphos methyl applications on gray-tailed voles (*Microtus canicaudus*) and deer mice (*Peromyscus maniculatus*) were studied in 0.2-ha alfalfa enclosures in Oregon. In one study, voles were exposed to a single ground-spray application of either 0, 0.7, 1.4, 2.8, or 4.2 lb ai/acre (Edge et al. 1996). Population levels in the 1.4 to 4.2 lb ai/acre enclosures were depressed for four weeks after application. Application at 0.7 lb ai/acre caused little or no detectible demographic responses. In another study, an application of 3.25 lb ai/acre reduced population density and growth, survival, recruitment, and body growth of voles (Schauber et al. 1997). Vole densities were only 40% of the controls and remained depressed for $\geq$ 6 weeks after the single spray application. Deer mouse densities in mowed enclosures also decreased 47% within five days after spraying. Analysis of deer mouse feces indicated that consumption of arthropods just after spraying was greater in treated enclosures than in untreated enclosures, indicating that the mice were eating dead or dying arthropods. A third study found that three applications of 1.45 lb ai/acre applied at 14-day intervals caused significant but short-term reductions in vole survival (Peterson 1996). In that study, effects on survival occurred immediately after application but did not persist for more than a week or two.

The effects of exposure on 12-day-old broods of bobwhite exposed to a single application of either 0, 0.7, or 2.8 lb ai/acre were examined in 0.2-ha alfalfa enclosures in Oregon (Matz et al. in prep.). Different broods were exposed for either 1-2 days post-treatment, 1-5 days post-treatment, or 6-10 days post-treatment. Chick survival probability for those exposed only for days 1-2 post-spray was not different from the controls for either treatment rate, but for those exposed days 1-5 it was significantly lower for the higher application rate. For chicks exposed only from days 6-10, survival probability was significantly lower than controls for both application rates. Treatment also reduced chick growth rates and brain AChE activity. Lowered growth rates indicate that food intake was decreased due to direct intoxication and/or avoidance of contaminated food.

b. Toxicity to Freshwater Aquatic Animals

i. Freshwater Fish, Acute

In order to establish the toxicity of a pesticide to freshwater fish, the minimum data required on the technical grade of the active ingredient are two freshwater fish toxicity studies. One study should use a cold water species (preferably the rainbow trout), and the other should use a warm water species (preferably the bluegill sunfish).

Table 41. Freshwater Fish Acute Toxicity Findings					
Species	**% A.I.**	**LC_{50} ppb (ug/L) a.i.**	**MRID No.**	**Toxicity Category**	**Fulfills Guideline Requirement**
Coho salmon	93 static	6.1	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Coho salmon	93 static	3.2	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Coho salmon	93 static	3.2	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Rainbow trout	93 static	4.3	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Rainbow trout	93 static	7.1	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Rainbow trout	93 static	5.8	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Rainbow trout	93 static	6.3	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Rainbow trout	93 static	2.9	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Atlantic salmon	93 static	2.1	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Atlantic salmon	93 static	2.7	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Atlantic salmon	93 static	3.2	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Atlantic salmon	93 static	3.5	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Atlantic salmon	93 static	>15	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Atlantic salmon	93 static	3.6	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental

Table 41. Freshwater Fish Acute Toxicity Findings					
Species	**% A.I.**	**LC_{50} ppb (ug/L) a.i.**	**MRID No.**	**Toxicity Category**	**Fulfills Guideline Requirement**
Atlantic salmon	93 static	2.5	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Atlantic salmon	93 flow-through	2.5	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Brown trout	93 static	4.6	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Brown trout	93 static	4.3	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Brown trout	93 static	3.5	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Brown trout	93 static	6.0	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Brown trout	93 static	5.1	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Brown trout	93 static	6.6	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Brook trout	93 static	1.2	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Goldfish	93 static	4270	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Carp	93 static	695	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Fathead minnow	93 static	235	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Fathead minnow	93 static	293	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Fathead minnow	93 static	148	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core

Table 41. Freshwater Fish Acute Toxicity Findings					
Species	**% A.I.**	**LC_{50} ppb (ug/L) a.i.**	**MRID No.**	**Toxicity Category**	**Fulfills Guideline Requirement**
Black bullhead	93 static	3500	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Black bullhead	93 static	4600	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Black bullhead	93 static	4810	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Channel catfish	93 static	3290	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Green sunfish	93 static	52	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Bluegill sunfish	93 static	22	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Bluegill sunfish	93 static	8.2	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Bluegill sunfish	93 static	8.0	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Bluegill sunfish	93 static	4.1	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Bluegill sunfish	93 static	17	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Bluegill sunfish	93 static	34	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Bluegill sunfish	93 flow-through	4.8	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Largemouth bass	93 static	4.8	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Black crappie	93 static	3.0	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental

Table 41. Freshwater Fish Acute Toxicity Findings					
Species	**% A.I.**	**LC_{50} ppb (ug/L) a.i.**	**MRID No.**	**Toxicity Category**	**Fulfills Guideline Requirement**
Yellow perch	93 static	15	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	93 static	40	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	93 static	5.6	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	93 static	2.4	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	93 static	17	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	93 static	29	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	93 static	8.5	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	93 static	29	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	93 static	18	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	93 static	36	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	93 static	11	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	93 static	27	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	0 Day Degradate static	10	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	7 Day Degradate static	24	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental

Table 41. Freshwater Fish Acute Toxicity Findings					
Species	**% A.I.**	**LC_{50} ppb (ug/L) a.i.**	**MRID No.**	**Toxicity Category**	**Fulfills Guideline Requirement**
Yellow perch	14 Day Degradate static	20	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	21 Day Degradate static	33	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Yellow perch	93 flow-through	6.5	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Bluegill sunfish	Guthion 2S (22% a.i.)	40.4	66046 Submitted by Mobay Co./1984	very highly toxic	supplemental
Rainbow trout	Guthion 2S (22% a.i.)	27.49	66046 Submitted by Mobay Co./1984	very highly toxic	supplemental
Goldorfe *(Leuciscus idus melanotus)*	92.6	120	67596 Submitted by Mobay Co./1984	very highly toxic	supplemental
Rainbow trout	Guthion 50% WP	8.8	EPA Registration No. 3125193 USEPA Biological Rept	very highly toxic	core for 50% WP

The results of the 96-hour acute toxicity studies indicate that azinphos-methyl is very highly toxic to freshwater fish. Although multiple studies on the rainbow trout, yellow perch and bluegill sunfish (MRID No. 40098001) were conducted at various temperatures, all of the endpoints are classified as very highly toxic. Furthermore, multiple studies (MRID No. 40098001) were also conducted with varying pH with yellow perch, brook trout and bluegill sunfish, and these studies resulted in toxicity endpoints (LC50's) that are classified as very highly toxic. The lowest toxicity endpoint was 1.2 ug ai/L on the brown trout. This is the endpoint that will be used in the acute freshwater fish risk assessment. The guideline requirements are fulfilled. (MRID 40098001)

Table 42. Freshwater Fish Acute Toxicity Findings at different life stages					
Species	**% A.I.**	**LC_{50} ppb (ug/L) a.i.**	**MRID No.**	**Toxicity Category**	**Fulfills Guideline Requirement**
Atlantic salmon (green egg)	93 static	>50	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental

Table 42. Freshwater Fish Acute Toxicity Findings at different life stages					
Species	**% A.I.**	**LC_{50} ppb (ug/L) a.i.**	**MRID No.**	**Toxicity Category**	**Fulfills Guideline Requirement**
Atlantic salmon (green egg)	93 static	>50	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Atlantic salmon (green egg)	93 static	>15	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Atlantic salmon (yolk-sac fry)	93 static	18	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Atlantic salmon (yolk-sac fry)	93 static	15	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Atlantic salmon (yolk-sac fry)	93 static	3.5	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Atlantic salmon (yolk-sac fry)	93 static	2.3	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Atlantic salmon (yolk-sac fry)	93 static	1.8	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Northern pike (yolk-sac fry)	93 static	0.36	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental

All of the above studies were conducted with fishes in various larval stages. These toxicity endpoint indicate that azinphos methyl is very highly toxic to fish in these life stages. This is supplemental information.

ii. Freshwater Fish, Chronic

Data from fish early life-stage tests or life-cycle tests with fish or aquatic invertebrates (on whichever species is most sensitive to the pesticide as determined from the results of the acute toxicity tests) are required if the product is applied directly to water or expected to be transported to water from the intended use site, and when the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent regardless of toxicity; or if any acute LC_{50} or EC_{50} is greater than 1 mg/L; or if the EEC in water is equal to or greater than 0.01 of any acute EC_{50} or LC_{50} value; or if the actual or estimated environmental concentration in water resulting from use is less than 0.01 of any acute EC_{50} or LC_{50} value and any of the following conditions exist: studies of other organisms indicate the reproductive physiology of fish and/or invertebrates may be affected; or physicochemical properties indicate cumulative effects; or the pesticide is persistent in water (e.g. half-life greater than 4 days).

A fish early life-stage test with freshwater fish is required for azinphos methyl because of the following: 1) The product is expected to be transported to water from the intended use site. This is demonstrate by the amount of aquatic incidence that has occurred using azinphos methyl. 2) According to the Tier 2 PRIZM/EXAMS surface water models azinphos methyl will be present in surface water in excess of the LC50 for marine/estuarine and freshwater fish and aquatic invertebrates for a period greater than four days. 3) The LC50s for marine/estuarine and freshwater fish and aquatic invertebrates is less than 1 ppm. A fish full life cycle study is required due to the above conditions and the reproductive effects observed in the fish early life stage study.

Table 43. Fish Early Life-Stage Toxicity Findings

Species	**% A.I.**	**NOAEC ug/L (ppb)**	**LOEC ppb (ug/L)**	**MATC ppb (ug/l)**	**MRID No. Author/Year**	**Endpoints Affected**	**Fulfills Guideline Requirement**
Freshwater: Rainbow trout	88.8	0.44	0.98	0.66	4057901 Surprenant/1987	60 days post hatch for: Larvae survivsal Length Weight	supplemental (no raw data submtd. only the mean values)
Freshwater: Rainbow trout	87.3	0.47	not detmd.	EC 10 of 0.29	073605 Lamb/1984	mean fish weight	supplemental (NOAEL not det. & no raw data submtd. only the mean values)

The results indicate that azinphos-methyl effects the 60 days post-hatch for larval survival, mean length, and mean weight of the rainbow trout. All of these endpoints had the same NOAEC. This study may be upgraded to core if the raw data is submitted. The guideline requirement is not fulfilled.

iii. Freshwater Invertebrates, Acute

The minimum testing required to assess the hazard of a pesticide to freshwater invertebrates is a freshwater aquatic invertebrate toxicity test, preferably using first instar *Daphnia magna* or early instar amphipods, stoneflies, mayflies, or midges.

Table 44. Freshwater Invertebrate Toxicity Findings					
Species	**% A.I.**	**EC_{50} ppb (ug/l)**	**MRID NO. Author/Year**	**Toxicity Category**	**Fulfills Guideline Requirement**
Asellus brevicaudus	93 static	96 hour EC50 = 21	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Gammarus fasciatus	93 static	48 hour EC50 = 0.25	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Gammarus fasciatus	93 static	48 hour EC50 = 0.16	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	core
Procambarus sp.	93 static	96 hour EC50 = 56	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Palaemonetes kadiakemsis	93 flow-through	96 hour EC50 = 1.2	40098001 F.L. Mayer & M.R. Ellersieck/1986	very highly toxic	supplemental
Pteronarcys californica	93 static	96 hour EC50 = 1.9	40098001 F. L. Mayer & M. R. Ellersieck/1986	very highly toxic	core
Daphnia magna	50 flow-through	48 hour EC50 = 4.8 ppm	40301302 Surprenant/1987	moderately toxic	core
Daphnia magna	90.6	48 hour EC50 = 1.13	68678 Submitted by Mobay Co./1984	very highly toxic	core

There is sufficient information to characterize azinphos methyl as moderately to very highly toxic to aquatic freshwater invertebrates. The lowest toxicity endpoint is 0.16 ug ai/L on *Gammarus fasciatus*. This is the endpoint that will be used in the acute freshwater invertebrate risk assessment. The guideline requirement is fulfilled. (MRID 68678; 40301302)

iv. Freshwater Invertebrate, Chronic

Table 45. Aquatic Invertebrate Life-Cycle Toxicity Findings							
Species	**% A.I.**	**NOAEC ug/L (ppb)**	**LOEC ug/L (ppb)**	**MATC ug/L (ppb)**	**Accession No. Author/Year**	**Endpoints Affected**	**Fulfills Guideline Requirement**
Daphnia magna	99.6 (flow-through)	0.25	0.4	>0.25 and <0.4	073606 Forbis/1984	adult mean length, survival, & young/adult /repro./day	core

The results indicate that the mean adult length, survival, and the number of young per adult per day reproduction were affected. The guideline requirement is fulfilled. (MRID 073606)

v. Freshwater Amphibians

Freshwater amphibian toxicity testing is not a normal data requirement for a freshwater risk assessment.

Table 46. Acute Amphibian Toxicity Findings				
Species	**% A.I.**	**LC50 ppb (ug/L)**	**MRID No. Author/Year**	**Fulfills Guideline Requirement**
Fowlers Toad	93 static	109	40098001 F.L. Mayer & M.R. Ellersieck/1986	supplemental
Western Chorus Frog	93 static	3200	40098001 F.L. Mayer & M.R. Ellersieck/1986	supplemental

The results indicate that azinphos methyl has acute effects (mortality) to amphibians at 109 ppb.

c. Toxicity to Estuarine and Marine Animals

i. Toxicity to Estuarine and Marine Animals, Acute

Acute toxicity testing with estuarine and marine organisms is required when an end-use product is intended for direct application to the marine/estuarine environment or is expected to reach this environment in significant concentrations. The terrestrial non-food use of azinphos methyl may result in exposure to the estuarine environment.

The requirements under this category include a 96-hour LC_{50} for an estuarine fish, a 96-hour LC_{50} for shrimp, and either a 48-hour embryo-larvae study or a 96-hour shell deposition study with oysters.

Table 47. Estuarine/Marine Acute Toxicity Findings					
Species	**% A.I.**	**LC_{50}/EC_{50} ppb (ug/L)**	**MRID No. Author/Year**	**Toxicity Category**	**Fulfills Guideline Requirement**
Eastern oyster embryo larvae *(Crassostrea virginica)*	96	96 hour EC50 = 1000	40228401 Mayer/1986	very highly toxic	core
Brown shrimp *(Penaeus aztecus)*	96	48 hour EC50 = 2.4	40228401 Mayer/1986	very highly toxic	core
Blue crab *(Callinectus sapidus)*	96	48 hour EC50 = 320	40228401 Mayer/1986	very highly toxic	supplemental
Spot *(Leiostomus xanthurus)*	96	48 hour LC50 = 28	40228401 Mayer/1986	very highly toxic	supplemental
Striped mullet *(Mugil cephalus)*	96	48 hour LC50 = 3.2	40228401 Mayer/1986	very highly toxic	supplemental
Sheepshead minnow *(Cyprinodon variegatus)*	Guthion 2L 22.3% ai Flow-through	96 hour LC50 = 1.86 (a.i.)	41202001 Boeri/1989	very highly toxic	core
Mysidopsis bahia (Mysid shrimp)	Guthion 2L 22.3% ai Flow-through	96 hour LC50 = 0.258 (a.i.)	41202002 Boeri/1989	very highly toxic	core
Sheepshead minnow *(Cyprinodon variegatus)*	88.8 Flow-through	96 hour LC50 = 2.7	40380501 Surprenant/1987	very highly toxic	core
Mysidopsis bahia	88.8 Flow-through	96 hour LC50 = 0.21	40380502 Surprenant/1987	very highly toxic	core
Eastern Oyster *(Crassostrea virginica)*	88.8	96 hour EC50 >3.1 mg/l (ppm)	40452001 Surprenant/1987	moderately toxic	core

There is sufficient information to characterize azinphos methyl as moderately to very highly toxic on an acute basis to estuarine/marine organisms. The following acute marine/estuarine endpoints will be used in the risk assessment: *(Mysidopsis bahia)* EC50 = 0.21 ug ai/L, Sheepshead minnow *(Cyprinodon variegatus)* LC50 = 2.7 ug ai/L. The guideline requirements are fulfilled. (MRID 40452001; 40380502; 40380501; 41202002; 41202001; 40228401)

ii. Estuarine and Marine, Chronic

The fish life-cycle test is required when an end-use product is intended to be applied directly to water or is expected to transport to water from the intended use site, when any of the following conditions apply: the EEC is equal to or greater than one-tenth of the NOAEL in the fish early life-stage or invertebrate life-cycle test; or if studies of other organisms indicate the reproductive physiology of fish may be affected.

A fish full life cycle test is required for azinphos methyl because of the following: 1) The product is expected to be transported to water from the intended use site. This is demonstrated by the amount of aquatic incidence that has occurred using azinphos methyl. 2) According to the Tier 2 PRZM/EXAMS surface water models azinphos methyl will be present in surface water in excess of the NOAEL for the freshwater fish and aquatic invertebrates. 3) Reproductive effects were observed in the fish early life stage study.

Table 48. Fish Life-Cycle Toxicity Findings

Species	% A.I.	NOAEC ppb (ug/l)	LOEC (ug/l)	MATC (ug/l)	MRID No. Author/Year	Endpoints Affected	Fulfills Guideline Requirement
Sheepshead Minnow	92.5	0.2	0.41	0.29	42021601 Dionne/1991	minnow survival & hatchling success of 2nd generation embryos	supplemental; raw water quality, fish growth data, & offspring data need to be submitted.

The results indicate that azinphos methyl affects minnow survival and hatchling success of second generation embryos. The guideline requirement is not fulfilled. This study may upgraded to core and the guideline requirement fulfilled by submitting the raw water quality data, fish growth data, and offspring for the control group. (MRID 42021601)

Toxicity to Plants

Currently, terrestrial and aquatic plant testing is not required for pesticides other than herbicides and fungicides except on a case-by case basis (e.g. labeling contains phytotoxicity warnings, incident data, or literature that demonstrates phytotoxicity). These conditions do not apply to azinphos methyl.

Azinphos methyl Incident Data

The azinphos methyl incidents occurred in the states of Louisiana, Georgia, California, North Carolina, Florida, Texas, Tennessee, Mississippi, New York, Missouri, Washington, and Arizona. The use sites that these Incidents were associated with were sugarcane, orchards (apples, crabapples, pears, almonds, filberts, walnuts, cherries, peaches, and plums), alfalfa, cotton, and citrus. The organisms that were effected were; fish, reptiles, large mammals, birds, bees, and aquatic invertebrates. Appendix I is a detailed summary of each incident that EFED has in the Incident Data System. The section below is a ***brief summary*** of the incidents according to azinphos methyl use sites.

Incidents - Summary

SUGAR CANE

The largest amount of incidents data that the agency has concerning azinphos methyl is on this crop (sugarcane) in Louisiana. These incidents occurred in the years 1991, 1992, 1994, and 1997. The method of application to sugarcane was aerial, and according to the Louisiana State Departments of Agriculture and Environmental Quality most cases the applicator followed the label instructions. It was documented in some of the state's reports that after azinphos methyl was applied it rained. In summary azinphos methyl was aerially applied then shortly after application it rained. When the rain event occurred it was likely that runoff from these treated fields into neighboring water bodies resulted in the kills of various organisms. However, fish kill incidents have also occurred without a rain event. Furthermore, azinphos methyl was found in some of these water bodies in excess of the acute LC50's and the chronic NOAEC's for fish and aquatic invertebrates that has been established in laboratory studies. The following are the estimated numbers of animals killed:

1) Fish and Aquatic Invertebrates: Fish kills, that have been associated with azinphos methyl, effected a wide variety of species including; alligator gar, carp, various sunfish, bowfin, bream, blue Catfish, buffalo, white perch, striped mullet, southern flounder, mosquito fish, spotted gar, atlantic croaker, white crappie, warmouth, gambusio, freshwater drum, gulf menhaden, largemouth bass, american eel, yellow bullhead, white bass, black bass, gizzard shad, silverside, ladyfish, yellow bass, channel catfish, and hog choker. The estimated number of fish killed as a result of azinphos methyl is 444,000 spread over 37 Incidents.

Dead aquatic invertebrates have been observed in two incidents, one was blue crab and in the second the organisms were reported as "some crustaceans".

2) Birds: Dead ducks were observed in one incident that was related in sugarcane. Also Louisiana state investigators have observed birds feeding on the dead and dying fish in some of the azinphos methyl related fish kills. This would indicate that birds are consuming azinphos methyl contaminated food, and could possibly cause adverse effects to them.

3) Reptiles: Dead alligator (4ft. long), turtles (Red Eared), and snakes have been observed in azinphos methyl related fish kills. In one case there was reported a 4 foot long alligator was

killed and the measured level of azinphos methyl in the water was from 2.5 to 18.6 ppb at this site. Furthermore, Louisiana state investigators have observed alligators, turtles, and snakes feeding on the dead and dying fish in some of the azinphos methyl related fish kills. This would indicate that these organisms are consuming azinphos methyl contaminated food, and this is leading to adverse effects in these organisms.

4) 1996 - Review of Incident Data for Azinphos methyl

The following is excerpted from a memorandum dated March 6, 1995 the subject was the Review of Incident Data for Azinphos methyl. This memo was from Anthony F. Maciorowski, Chief, EEB to Evert K. Byington, Chief, SACS (DP Barcode: D213008):

EEB Comments:

"Regarding the "1994 Fish Kill Investigation"; The report lists 51 fish kills as having been caused by low D.O., however, there is no clarification in the report as to how this cause and effect was determined. Is it possible that instead of the low D.O. killing fish, the fish might have been killed by pesticide runoff resulting in low D.O.? For example, in the Opelousas fish kill (see above) the LDEQ concluded that the kill was caused by low D.O.. Only after the LDAF had examined the results of the water sample analysis did LDAF conclude that the kill was caused by pesticide drift from an aerial application. There is no indication that water samples were taken during the investigation of the 51 fish kills attributed to low D.O.."

COTTON

Azinphos methyl incidents as a result of its use on cotton have occurred in the states of Georgia, Tennessee, Mississippi, and Texas. The organisms that were effected were fish and livestock.

1) Georgia: According to the Ecological Incident Information System and the investigative reports from the state of Georgia, there are listed aquatic incidents that occurred in Georgia in September and October of 1987. All of these were associated with aerially applied azinphos methyl to cotton. A total of 82 incidents occurred in the following counties; Baker, Beckley, Brooks, Calhoun, Colquitt, Cook, Crisp, Dodge, Dooly, Grady, Lanier, Laurens, Ocnee, Pulaski, Thomas, Tift, Turner, and Wilcox. The fish species affected were bream, bass and catfish. Approximately the total number of fish affected were 100,000 over this two month period. Additional terrestrial incidents occurred in Brooks County. The animals affected were a cow, a pig, and a parakeet.

The investigative reports from the state of Georgia indicated the approximate distance from the application site to the incident site, the concentration of azinphos methyl in the water body where the incidents took place, and foliar analysis of the vegetation surrounding the incident site. Azinphos methyl moved off the application site from 20 to 3000 feet. Only one incident report indicated that there was precipitation after application. The analytical results that were reported in the 82 incidents were; from 0.30 to 5.34 ppb in water, and 0.41 to 20.2 ppm on foliage.

<u>2) Tennessee, Mississippi, Missouri, and Texas:</u> In Tennessee there were two fish kills but their numbers were not reported. In Mississippi there were two fish kills in one there were 5000 fish effected. In Texas was one fish kill with forty fish. In Missouri had one incident with one horse affected associated with cotton use.

ORCHARDS

Azinphos methyl incidents as a result of its use on orchards has occurred in the states of North Carolina (3 incidents with bees), California (2 fish kills one with 3000 fish), Missouri (1 fish kill with 325 fish), New York (2 fish kills), Washington (1 fish kill) and Florida (1 fish kill with 1500 fish). Orchards includes uses on apples, walnuts/almonds, citrus, and peaches.

ALFALFA

Azinphos methyl incidents as a result of its use on alfalfa has occurred in the state of California in which 1 incident with 13 birds and 1 fish killed. Residue analysis reported the following levels of Azinphos methyl: feathers 3 ppm, GI tract (birds) 16 ppm, and alfalfa 17 ppm occurred.

4. Ecological Risk Assessment

EFED compares risk quotients (RQ's) to levels of concern (LOC's) to assess the potential for adverse ecological effects. RQ's are determined by comparing potential exposure values, i.e., estimated environmental concentrations (EEC's), with ecotoxicity values, where

RQ = EEC / TOXICITY

Risk presumptions are made by comparing acute and chronic RQ's to the LOC's for birds, mammals, and aquatic organisms. Exceedance of an LOC indicates the potential for serious risk to non-target organisms and the need for the Agency to consider regulatory action. LOC's are used to address the following risk presumption categories: (1) **acute high risk** - regulatory action may be warranted to eliminate or reduce risk; (2) **acute restricted use** - risk may be mitigated by restricted use classification; (3) **acute endangered species** - regulatory action may be warranted to protect endangered species; and (4) **chronic risk** - regulatory action may be warranted to eliminate or reduce chronic risk.

The ecotoxicity values for acute effects are: (1) LC50 (fish, birds); (2) LD50 (birds, mammals); (3) EC50 (aquatic plants, aquatic invertebrates); and (4) EC25 (terrestrial plants). Ecotoxicity values for chronic effects are: (1) LOEC (birds, fish, aquatic invertebrates); (2) NOAEC (birds, mammals, fish, aquatic invertebrates); and (3) MATC (fish, aquatic invertebrates). The MATC (geometric mean of the NOAEC and LOEC) is generally used for assessing chronic effects to fish and aquatic invertebrates, but the NOAEC may be used if the measurement endpoint is survival or production of offspring.

Table 49. Risk Presumptions for Birds and Small Wild Mammals

Risk Presumption	RQ	LOC
Acute High Risk	EEC[1]/LC50 or LD50/sqft[2] or LD50/day[3]	0.5
Acute Restricted Use	EEC/LC50 or LD50/sqft or LD50/day (or LD50 < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC50 or LD50/sqft or LD50/day	0.1
Chronic Risk	EEC/NOAEC	1

[1] EEC = Estimated Environmental Concentration (ppm) on avian and mammalian food items
[2] mg toxicant/ft^2 ÷ [LD50 * bird wt (kg)]
[3] mg toxicant consumed/day ÷ [LD50 * bird wt (kg)]

Table 50. Risk Presumptions for Aquatic Animals

Risk Presumption	RQ	LOC
Acute High Risk	EEC[1]/LC50 or EC50	0.5
Acute Restricted Use	EEC/LC50 or EC50	0.1
Acute Endangered Species	EEC/LC50 or EC50	0.05
Chronic Risk	EEC/MATC or NOAEC	1

[1] EEC = Estimated Environmental Concentration (ppm or ppb) in water

The following azinphos methyl toxicological endpoints will be used for determining risk quotients in this document:

Avian acute risk: Northern Bobwhite LC_{50} 488 ppm

Avian chronic risk :	Mallard NOAEC	10.5 ppm
Acute mammalian risk:	Gray-tailed Vole LC_{50}	406 ppm
Chronic mammalian risk:	Laboratory Rat NOAEC	5 ppm
Acute freshwater fish risk:	Brook Trout LC_{50}	1.2 ppb
	Rainbow Trout LC_{50}	2.9 ppb
	Bluegill Sunfish LC_{50}	4.1 ppb
Chronic freshwater fish risk:	Rainbow Trout NOAEC	0.23 ppb
Acute freshwater invertebrates risk:	*Gammarus fasciatus* EC_{50}	0.16 ppb
	Daphnia magna LC_{50}	1.13 ppb
Chronic freshwater invertebrates:	*Daphnia magna* NOAEC	0.25 ppb
Acute estuarine fish:	Sheepshead Minnow LC_{50}	2.7 ppb
Chronic estuarine fish:	Sheepshead Minnow NOAEC	0.2 ppb
Acute estuarine invertebrate:	Mysid shrimp LC_{50}	0.21ppb

Exposure and Risk to Non-target Terrestrial Animals

Avian and Mammalian Risk Assessment Summary

Based on maximum EECs on short grass, the acute high risk LOC's for herbivorous birds and small mammals are exceeded for most use sites. The restricted use and endangered species LOC's are exceeded for all use sites. Based on mean EECs, the acute high risk LOC is exceeded for apples, crabapples, pears, quince, citrus, pecans, walnuts, filberts, and tomatoes. The endangered species LOC is exceeded for all use sites except for birds for small grain crops (wheat, barley, rye, oats).

For insectivores, the acute high risk LOC is exceeded for many use sites, including apples, conventional application to cotton in California and Arizona, and peaches, when risk quotients are based on maximum EEC's on small insects. The endangered species LOC is exceeded for all use sites. The acute high risk LOC is not exceeded for any use site when RQs are based on mean EEC's, but the restricted use LOC is exceeded for apples, crabapples, pears, quince, citrus, plums, prunes, peaches and nectarines (mammals only), all nut crops, tomatoes, artichokes, and black-eyed peas. The endangered species LOC is exceeded for all use sites except blackberries, boysenberries, loganberries, raspberries, and small grain crops.

The acute high risk and restricted use LOC's are not exceeded for seed-eating birds and mammals for any use site. The endangered species LOC is exceeded for several use sites, including apples, when maximum EECs are presumed on seeds.

The chronic risk LOC for birds is exceeded for herbivores and insectivores for all use sites for both maximum and mean EECs. Based on maximum EECs on seeds, the chronic risk LOC is exceeded for all sites except cherries, pomegranates, blackberries, boysenberries, loganberries, raspberries, beans (snap, dried), celery, peppers, parsley, cucumber, eggplant, spinach, cotton (ULV application), alfalfa, and sugar cane. Based on mean EECs on seeds, the chronic risk LOC is exceeded for all crops except those specified above and peaches (eastern), nectarines (eastern), cranberries, grapes, blueberries, strawberries, melons, almonds, artichokes, black-eyed peas, potatoes, onions, cole crops, cotton (conventional applications), and soybeans.

Field and pen studies support the presumptions of acute high risk to birds and small mammals. Field studies conducted in Michigan and Washington apple orchards demonstrated mortality of birds and small mammals after applications of azinphos methyl at maximum labeled application rates. Pen studies in alfalfa enclosures indicated that single applications of azinphos methyl can have adverse effects on gray-tailed voles, deer mice, and northern bobwhite chicks. Multiple applications in alfalfa enclosures demonstrated short-term effects on vole survival, but effects were additive with repeated applications. Collectively, these studies indicate that some bird and small mammal mortality is likely from field applications of azinphos methyl.

Risk to Non-Target Terrestrial Animals

i. Birds, Acute and Chronic

Acute RQ's based on maximum and mean EECs are tabulated separately below for fruit crops, nut crops, vegetable crops, and field crops.

Table 51. Avian Acute Risk Quotients for Foliar Applications on Fruit Crops, Based on the Northern Bobwhite LC50 of 488 ppm

Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Max. EEC (ppm)	Mean EEC (ppm)	Acute RQ (Max. EEC/ LC50)	Acute RQ (Mean EEC/ LC50)
Apples, Crabapples, Pears, Quince	1.5	4 (7)	Short grass Small insects Seeds	795 447 50	282 149 23	1.63 *** 0.92 *** 0.10 *	0.58 *** 0.30 ** 0.05
Citrus	2	2 (ns[1])	Short grass Small insects Seeds	773 435 48	274 145 22	1.58 *** 0.89 *** 0.10 *	0.56 *** 0.30 ** 0.05
Plums, Prunes (eastern)	1.5	2 (10)	Short grass Small insects Seeds	537 302 34	190 101 16	1.10 *** 0.62 *** 0.07	0.34 ** 0.21 ** 0.03
Plums, Prunes (western)	2	1	Short grass Small insects Seeds	480 270 30	170 90 14	0.98 *** 0.55 *** 0.06	0.35 ** 0.18 * 0.03
Peaches, Apricots, Nectarines (eastern)	1.125	3 (14)	Short grass Small insects Seeds	408 230 26	145 77 12	0.84 *** 0.47 ** 0.05	0.30 ** 0.16 * 0.02
Peaches, Apricots, Nectarines (western)	2	1	Short grass Small insects Seeds	480 270 30	170 90 14	0.98 *** 0.55 *** 0.06	0.35 ** 0.18 * 0.03
Cranberries, Grapes	1	3 (14)	Short grass Small insects Seeds	362 203 23	128 72 11	0.74 *** 0.42 ** 0.05	0.26 ** 0.14 * 0.02
Blueberries	0.75	3 (10)	Short grass Small insects Seeds	312 176 20	111 59 9	0.64 *** 0.36 ** 0.04	0.23 ** 0.12 * 0.02
Strawberries	0.5	4 (5)	Short grass Small insects Seeds	305 172 19	108 57 9	0.62 *** 0.35 ** 0.04	0.22 ** 0.12 * 0.02
Cherries (eastern)	0.75	4 (14)	Short grass Small insects Seeds	281 158 18	100 53 8	0.58 *** 0.32 ** 0.04	0.20 ** 0.11 * 0.04
Melons	0.5	3 (5)	Short grass Small insects Seeds	263 148 16	93 52 7	0.54 *** 0.30 ** 0.03	0.19 * 0.11 * 0.02
Pomegranates	1	2 (30)	Short grass Small insects Seeds	269 151 17	95 53 8	0.55 *** 0.31 ** 0.03	0.19 * 0.11 * 0.02
Blackberries, Boysenberries, Loganberries, Raspberries	0.5	2 (ns[1])	Short grass Small insects Seeds	193 108 12	68 38 6	0.40 ** 0.22 ** 0.02	0.14 * 0.08 0.01

[1] when not specified (ns) on product labels, an application interval of 7 days is assumed
*** exceeds acute high risk (0.5), acute restricted use (0.2), and acute endangered species (0.1) LOC's
** exceeds acute restricted use and acute endangered species LOC's
* exceeds acute endangered species LOC

Table 52. Avian Acute Risk Quotients for Foliar Applications to Nut Crops, Based on a Northern Bobwhite LC50 of 488 ppm

Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Max. EEC (ppm)	Mean EEC (ppm)	Acute RQ (Max. EEC/ LC50)	Acute RQ (Mean EEC/ LC50)
Pecans	2	3 (7)	Short grass	951	337	1.95 ***	0.69 ***
			Small insects	535	178	1.10 ***	0.36 **
			Seeds	59	28	0.12	0.06
Walnuts, Filberts	2	3 (14)	Short grass	725	257	1.49 ***	0.53 ***
			Small insects	408	136	0.84 ***	0.28 **
			Seeds	45	21	0.09	0.04
Pistachios	2.5	1	Short grass	600	212	1.23 ***	0.43 **
			Small insects	337	119	0.69 ***	0.24 **
			Seeds	38	17	0.08	0.03
Almonds	2	2 (30)	Short grass	538	191	1.10 ***	0.39 **
			Small insects	303	101	0.62 ***	0.21 **
			Seeds	34	16	0.07	0.03

[1] when not specified (ns) on product labels, an application interval of 7 days is assumed
*** exceeds acute high risk (0.5), acute restricted use (0.2), and acute endangered species (0.1) LOC's
** exceeds acute restricted use and acute endangered species LOC's
* exceeds acute endangered species LOC

Table 53. Avian Acute Risk Quotients for Foliar Applications on Vegetable Crops, Based on a Northern Bobwhite LC50 of 488 ppm

Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Max. EEC (ppm)	Mean EEC (ppm)	Acute RQ (Max. EEC/ LC50)	Acute RQ (Mean EEC/ LC50)
Tomatoes	1.5	4 (7)	Short grass Small insects Seeds	795 447 50	282 149 23	1.63 *** 0.92 *** 0.10	0.58 *** 0.300 ** 0.05
Artichokes	1.5	3 (14)	Short grass Small insects Seeds	543 305 34	192 108 16	1.11 *** 0.63 *** 0.07	0.39 ** 0.22 ** 0.03
Black-eyed peas	1	4 (ns[1])	Short grass Small insects Seeds	530 298 33	188 99 15	1.09 *** 0.61 *** 0.07	0.39 ** 0.20 ** 0.03
Beans (snap, dried)	0.5	4 (ns[1])	Short grass Small insects Seeds	265 149 17	94 50 8	0.54 *** 0.31 ** 0.03	0.19 * 0.10 * 0.02
Potatoes, Broccoli, Brussel sprouts, Cabbage, Cauliflower, Onions	0.75	3 (7)	Short grass Small insects Seeds	357 201 22	126 67 10	0.73 *** 0.41 ** 0.05	0.26 ** 0.14 * 0.02
Celery, Peppers, Parsley, Cucumber, Eggplant, Spinach	0.5	3 (7 or ns[1])	Short grass Small insects Seeds	238 134 15	84 47 7	0.49 ** 0.27 ** 0.03	0.17 * 0.10 * 0.01

[1] when not specified (ns) on product labels, an application interval of 7 days is assumed
*** exceeds acute high risk (0.5), acute restricted use (0.2), and acute endangered species (0.1) LOC's
** exceeds acute restricted use and acute endangered species LOC's
* exceeds acute endangered species LOC

Table 54. Avian Acute Risk Quotients for Foliar Applications on Field Crops, Based on a Northern Bobwhite LC50 of 488 ppm

Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Max. EEC (ppm)	Mean EEC (ppm)	Acute RQ (Max. EEC/ LC50)	Acute RQ (Mean EEC/ LC50)
Cotton (conventional appl.)	0.5	12 (ns[1])	Short grass Small insects Seeds	306 172 19	108 57 9	0.63 *** 0.35 ** 0.04	0.22 ** 0.12 * 0.02
Cotton (CA, AZ) (conv. appl.)	0.75	8 (ns[1])	Short grass Small insects Seeds	452 254 28	160 85 13	0.93 *** 0.52 *** 0.06	0.33 ** 0.17 * 0.03
Cotton (ULV appl.)	0.25	12 (ns[1])	Short grass Small insects Seeds	153 86 10	54 29 5	0.31 ** 0.17 * 0.02	0.11 * 0.06 0.01
Alfalfa	0.75	2/cutting (10)	Short grass Small insects Seeds	269 151 17	95 53 8	0.55 *** 0.31 ** 0.03	0.19 * 0.11 * 0.02
Soybeans	0.75	2 (ns[1])	Short grass Small insects Seeds	290 163 18	103 58 8	0.59 *** 0.33 ** 0.04	0.21 ** 0.12 * 0.02
Sugarcane	0.75	5 (21)	Short grass Small insects Seeds	233 131 15	83 44 7	0.48 ** 0.27 ** 0.03	0.17 * 0.09 0.01
Wheat, Barley, Rye, Oats	0.5	1	Short grass Small insects Seeds	120 67 8	42 24 4	0.25 ** 0.14 * 0.02	0.09 0.05 0.01

[1] when not specified (ns) on product labels, an application interval of 7 days is assumed
*** exceeds acute high risk (0.5), acute restricted use (0.2), and acute endangered species (0.1) LOC's
** exceeds acute restricted use and acute endangered species LOC's
* exceeds acute endangered species LOC

Herbivorous birds: Based on maximum EEC's on avian food items, the acute high risk LOC is exceeded for all use sites except blackberries, boysenberries, loganberries, raspberries, celery, peppers, parsley, cucumber, eggplant, spinach, ULV cotton application, sugarcane, wheat, barley, rye, and oats. The restricted use and endangered species LOC's are exceeded for all use sites.

Based on mean EEC's, the acute high risk LOC is exceeded for apples, crabapples, pears, quince, citrus, pecans, walnuts, filberts, and tomatoes. The restricted use LOC also is exceeded for plums, prunes, peaches, apricots, nectarines, cranberries, grapes, blueberries, cherries, strawberries, pistachios, almonds, artichokes, black-eyed peas, potatoes, onions, cole crops, cotton (conventional applications), and soybeans. The endangered species LOC is exceeded for all use sites except the small grain crops (wheat, barley, rye, oats).

Insectivorous birds: Based on maximum EEC's, the acute high risk LOC is exceeded for apples, crabapples, pears, quince, citrus, plums, prunes, peaches (western), apricots (western), nectarines (western), all nut crops, tomatoes, artichokes, black-eyed peas, and conventional application to cotton in CA and AZ. The restricted use LOC also is exceeded for peaches (eastern), apricots (eastern), nectarines (eastern), all berry crops, grapes, cherries, melons, pomegranates, beans (snap, dried), potatoes, the cole crops, onions, celery, peppers, parsley, cucumber, eggplant, spinach, conventional cotton application, alfalfa, soybeans, and sugarcane. The endangered species LOC is exceeded for all use sites.

The acute high risk LOC is not exceeded for any use site when RQ's are based on mean EECs. The restricted use LOC is exceeded for apples, crabapples, pears, quince, citrus, plums (eastern), prunes (eastern), all nut crops, tomatoes, artichokes, and black-eyed peas. The endangered species LOC is exceeded for all use sites except blackberries, boysenberries, loganberries, and raspberries.

Granivorous birds: The only LOC exceeded for seed-eating birds is for endangered species for the use sites apples, crabapples, pears, quince, and citrus and only when maximum EECs are presumed on seeds.

The presumptions of acute high risk to herbivorous and insectivorous birds are supported by the field studies in Michigan (MRID 411959-01) and Washington (MRID 411397-01) apple orchards. The studies indicate that some avian mortality will occur in orchards and that residues, although highly variable among sampling sites, may sometimes even exceed those predicted by the Kenaga nomogram. Residues on apple tree foliage were measured within 24 hours of spray blast applications. After the first application, measured residues (236 and 201 ppm) in both studies were comparable to the predicted maximum "Fletcher" EEC (203 ppm), although individual samples ranged as high as 476 ppm. In Michigan, residues measured after the second and third applications were 429 ppm (111-1499 ppm) and 536 ppm (208-1747 ppm), respectively, which is higher than predicted (327 ppm and 402 ppm, respectively). In Washington, measured residues after the second and third application were 312 ppm (123-564 ppm) and 328 ppm (122-611 ppm), respectively. Measured residues on other orchard vegetation averaged 26-47% of those on the apple tree foliage. Insects were sampled 24 to 48 hours after application, but few were found, presumably due to high mortality. However, residues on exposed insects on apple trees likely would be comparable to those on the apple tree foliage immediately after application.

The pen study conducted with bobwhite broods in Oregon indicated that survival of chicks was significantly reduced following exposure to alfalfa treated with a single application of azinphos methyl (Matz et al. in prep.). Evidence of direct toxicity (e.g., drooping wings, lethargy, muscle tremors, and death) was observed, but the authors also speculated exposed chicks may have been more susceptible to predation from diurnal raptors observed over the experimental plots. If so, the potential for secondary exposure and mortality of predators also exists and should be investigated.

Chronic RQ's for foliar applications of azinphos methyl are tabulated below.

Table . Avian Chronic Risk Quotients for Foliar Applications on Fruit Crops, Based on the Northern Bobwhite NOAEC of 10.5 ppm

Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Avg. Max. EEC (ppm)	Avg. Mean EEC (ppm)	Chronic RQ (Avg. Max. EEC/NOAEC)	Chronic RQ (Avg. Mean EEC/NOAEC)
Apples, Crabapples, Pears, Quince	1.5	4 (7)	Short grass	495	175	47 +	17 +
			Small insects	262	87	25 +	8 +
			Seeds	41	19	4 +	2 +
Citrus	2	2 (ns[1])	Short grass	509	180	49 +	17 +
			Small insects	269	89	26 +	9 +
			Seeds	42	20	4 +	2 +
Plums, Prunes (eastern)	1.5	2 (10)	Short grass	330	117	31 +	11 +
			Small insects	175	58	17 +	6 +
			Seeds	27	13	3 +	1 +
Peaches, Apricots, Nectarines (eastern)	1.125	3 (14)	Short grass	205	73	20 +	7 +
			Small insects	109	36	10 +	3 +
			Seeds	17	8	2 +	<1
Cranberries, Grapes	1	3 (14)	Short grass	203	72	19 +	7 +
			Small insects	114	38	11 +	4 +
			Seeds	13	6	1 +	<1
Blueberries	0.75	3 (10)	Short grass	187	66	18 +	6 +
			Small insects	99	33	9 +	3 +
			Seeds	15	7	1 +	<1
Strawberries	0.5	4 (5)	Short grass	196	69	19 +	7 +
			Small insects	104	35	10 +	3 +
			Seeds	16	7	2 +	<1
Cherries (eastern)	0.75	4 (14)	Short grass	155	55	15 +	5 +
			Small insects	87	29	8 +	3 +
			Seeds	10	5	<1	<1
Melons	0.5	3 (5)	Short grass	172	61	16 +	6 +
			Small insects	97	32	9 +	3 +
			Seeds	11	5	1 +	<1
Pomegranates	1	2 (30)	Short grass	108	38	10 +	4 +
			Small insects	61	20	6 +	2 +
			Seeds	7	3	<1	<1
Blackberries, Boysenberries, Loganberries, Raspberries	0.5	2 (ns[1])	Short grass	127	45	12 +	4 +
			Small insects	71	24	7 +	2 +
			Seeds	8	4	<1	<1

[1] when not specified (ns) on product labels, an application interval of 7 days is assumed
+ exceeds the chronic LOC (1)

Table 55. Avian Chronic Risk Quotients for Foliar Applications to Nut Crops, Based on a Northern Bobwhite NOAEC of 10.5 ppm

Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Avg. Max. EEC (ppm)	Avg. Mean EEC (ppm)	Chronic RQ (Avg. Max. EEC/NOAEC)	Chronic RQ (Avg. Mean EEC/NOAEC)
Pecans	2	3 (7)	Short grass	599	212	57 +	20 +
			Small insects	317	106	30 +	10 +
			Seeds	49	23	5 +	2 +
Walnuts, Filberts	2	3 (14)	Short grass	394	139	38 +	13 +
			Small insects	209	69	20 +	7 +
			Seeds	32	15	3 +	1 +
Almonds	2	2 (30)	Short grass	216	76	21 +	7 +
			Small insects	114	38	11 +	4 +
			Seeds	18	8	2 +	<1

[1] when not specified (ns) on product labels, an application interval of 7 days is assumed
+ exceeds the chronic LOC (1)

Table 56. Avian Chronic Risk Quotients for Foliar Applications on Vegetable Crops, Based on a Northern Bobwhite NOAEC of 10.5 ppm							
Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Avg. Max. EEC (ppm)	Avg. Mean EEC (ppm)	Chronic RQ (Avg. Max. EEC/NOAEC)	Chronic RQ (Avg. Mean EEC/NOAEC)
Tomatoes	1.5	4 (7)	Short grass	495	175	47 +	17 +
			Small insects	262	87	25 +	8 +
			Seeds	41	19	4 +	2 +
Artichokes	1.5	3 (14)	Short grass	304	108	29 +	10 +
			Small insects	171	57	16 +	5 +
			Seeds	19	9	2 +	<1
Black-eyed peas	1	4 (ns[1])	Short grass	333	118	32 +	11 +
			Small insects	187	62	18 +	6 +
			Seeds	21	9	2 +	<1
Beans (snap, dried)	0.5	4 (ns[1])	Short grass	166	59	16 +	6 +
			Small insects	93	31	9 +	3 +
			Seeds	10	5	<1	<1
Potatoes, Broccoli, Brussel sprouts, Cabbage, Cauliflower, Onions	0.75	3 (7)	Short grass	225	80	21 +	8 +
			Small insects	119	39	11 +	4 +
			Seeds	18	8	2 +	<1
Celery, Peppers, Parsley, Cucumber, Eggplant, Spinach	0.5	3 (7 or ns[1])	Short grass	150	53	14 +	5 +
			Small insects	84	28	8 +	3 +
			Seeds	9	4	<1	<1

[1] when not specified (ns) on product labels, an application interval of 7 days is assumed
+ exceeds the chronic LOC (1)

Table 57. Avian Chronic Risk Quotients for Foliar Applications on Field Crops, Based on a Northern Bobwhite NOAEC of 10.5 ppm							
Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Avg. Max. EEC (ppm)	Avg. Mean EEC (ppm)	Chronic RQ (Avg. Max. EEC/NOAEC)	Chronic RQ (Avg. Mean EEC/NOAEC)
Cotton (conventional appl.)	0.5	12 (ns[1])	Short grass Small insects Seeds	206 116 13	73 39 6	20 + 11 + 1 +	7 + 4 + <1
Cotton (CA, AZ) (conv. appl.)	0.75	8 (ns[1])	Short grass Small insects Seeds	304 171 19	108 57 9	29 + 16 + 2 +	10 + 5 + <1
Cotton (ULV appl.)	0.25	12 (ns[1])	Short grass Small insects Seeds	103 55 8	36 18 4	10 + 5 + <1	3 + 2 + <1
Alfalfa	0.75	2/cutting (10)	Short grass Small insects Seeds	165 93 10	58 31 5	16 + 9 + <1	6 + 3 + <1
Soybeans	0.75	2 (ns[1])	Short grass Small insects Seeds	191 107 12	68 36 6	18 + 10 + 1 +	7 + 3 + <1
Sugarcane	0.75	5 (21)	Short grass Small insects Seeds	114 60 9	40 20 4	11 + 6 + <1	4 + 2 + <1

[1] when not specified (ns) on product labels, an application interval of 7 days is assumed
+ exceeds the chronic LOC (1)

The chronic risk LOC for birds is exceeded for herbivores and insectivores for all use sites for both maximum and mean EEC's. Based on maximum EEC's on seeds, the chronic risk LOC is exceeded for all sites except cherries, pomegranates, blackberries, boysenberries, loganberries, raspberries, beans (snap, dried), celery, peppers, parsley, cucumber, eggplant, spinach, cotton (ULV application), alfalfa, and sugarcane. Based on mean EECs on seeds, the chronic risk LOC is exceeded for all crops except those specified above and peaches (eastern), apricots (eastern), nectarines (eastern), cranberries, grapes, blueberries, strawberries, melons, almonds, artichokes, black-eyed peas, potatoes, onions, cole crops, cotton (conventional applications), and soybeans.

ii. Mammals, Acute and Chronic

Acute RQ's based on maximum and mean EEC's are tabulated separately below for fruit crops, nut crops, vegetable crops, and field crops.

Table 58. Mammalian Acute Risk Quotients for Foliar Applications on Fruit Crops, Based on a Gray-tailed Vole LC50 of 406 ppm

Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Max. EEC (ppm)	Mean EEC (ppm)	Acute RQ (Max. EEC/ LC50)	Acute RQ (Mean EEC/ LC50)
Apples, Crabapples, Pears, Quince	1.5	4 (7)	Short grass	795	282	1.96 ***	0.69 ***
			Small insects	447	149	1.10 ***	0.37 **
			Seeds	50	23	0.12 *	0.06
Citrus	2	2 (ns[1])	Short grass	773	274	1.90 ***	0.67 ***
			Small insects	435	145	1.07 ***	0.36 **
			Seeds	48	22	0.12 *	0.05
Plums, Prunes (eastern)	1.5	2 (10)	Short grass	537	190	1.32 ***	0.45 **
			Small insects	302	101	0.74 ***	0.25 **
			Seeds	34	16	0.08	0.04
Plums, Prunes (western)	2	1	Short grass	480	170	1.18 ***	0.42 **
			Small insects	270	90	0.67 ***	0.22 **
			Seeds	30	14	0.07	0.03
Peaches, Apricots, Nectarines (eastern)	1.125	3 (14)	Short grass	408	145	1.00 ***	0.36 **
			Small insects	230	77	0.57 ***	0.19 *
			Seeds	26	12	0.06	0.03
Peaches, Apricots, Nectarines (western)	2	1	Short grass	480	170	1.18 ***	0.42 **
			Small insects	270	90	0.67 ***	0.22 **
			Seeds	30	14	0.07	0.03
Cranberries, Grapes	1	3 (14)	Short grass	362	128	0.89 ***	0.32 **
			Small insects	203	72	0.50 ***	0.18 *
			Seeds	23	11	0.06	0.03
Blueberries	0.75	3 (10)	Short grass	312	111	0.77 ***	0.27 **
			Small insects	176	59	0.43 **	0.15 *
			Seeds	20	9	0.05	0.02
Strawberries	0.5	4 (5)	Short grass	305	108	0.75 ***	0.27 **
			Small insects	172	57	0.42 **	0.14 *
			Seeds	19	9	0.05	0.02
Cherries (eastern)	0.75	4 (14)	Short grass	281	100	0.69 ***	0.25 **
			Small insects	158	53	0.39 **	0.13 *
			Seeds	18	8	0.04	0.02
Melons	0.5	3 (5)	Short grass	263	93	0.65 ***	0.23 **
			Small insects	148	52	0.36 **	0.13 *
			Seeds	16	7	0.04	0.02
Pomegranates	1	2 (30)	Short grass	269	95	0.66 ***	0.23 **
			Small insects	151	53	0.37 **	0.13 *
			Seeds	17	8	0.04	0.02
Blackberries, Boysenberries, Loganberries, Raspberries	0.5	2 (ns[1])	Short grass	193	68	0.48 **	0.17 *
			Small insects	108	38	0.27 **	0.09
			Seeds	12	6	0.03	0.01

1 when not specified (ns) on product labels, an application interval of 7 days is assumed
*** exceeds acute high risk (0.5), acute restricted use (0.2), and acute endangered species (0.1) LOC's
** exceeds acute restricted use and acute endangered species LOC's
* exceeds acute endangered species LOC

Table 59. Mammalian Acute Risk Quotients for Foliar Applications to Nut Crops, Based on a Gray-tailed Vole LC50 of 406 ppm

Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Max. EEC (ppm)	Mean EEC (ppm)	Acute RQ (Max. EEC/ LC50)	Acute RQ (Mean EEC/ LC50)
Pecans	2	3 (7)	Short grass	951	337	2.34 ***	0.83 ***
			Small insects	535	178	1.32 ***	0.44 **
			Seeds	59	28	0.15 *	0.07
Walnuts, Filberts	2	3 (14)	Short grass	725	257	1.79 ***	0.63 ***
			Small insects	408	136	1.00 ***	0.34 **
			Seeds	45	21	0.11 *	0.05
Pistachios	2.5	1	Short grass	600	212	1.48 ***	0.52 ***
			Small insects	337	119	0.83 ***	0.29 **
			Seeds	38	17	0.09	0.04
Almonds	2	2 (30)	Short grass	538	191	1.33 ***	0.47 **
			Small insects	303	101	0.75 ***	0.25 **
			Seeds	34	16	0.08	0.04

[1] when not specified (ns) on product labels, an application interval of 7 days is assumed
*** exceeds acute high risk (0.5), acute restricted use (0.2), and acute endangered species (0.1) LOC's
** exceeds acute restricted use and acute endangered species LOC's
* exceeds acute endangered species LOC

Table 60. Mammalian Acute Risk Quotients for Foliar Applications on Vegetable Crops, Based on a Gray-tailed Vole LC50 of 406 ppm

Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Max. EEC (ppm)	Mean EEC (ppm)	Acute RQ (Max. EEC/ LC50)	Acute RQ (Mean EEC/ LC50)
Tomatoes	1.5	4 (7)	Short grass	795	282	1.96 ***	0.69 ***
			Small insects	447	149	1.10 ***	0.37 **
			Seeds	50	23	0.12 *	0.06
Artichokes	1.5	3 (14)	Short grass	543	192	1.34 ***	0.47 **
			Small insects	305	108	0.75 ***	0.27 **
			Seeds	34	16	0.08	0.04
Black-eyed peas	1	4 (ns[1])	Short grass	530	188	1.31 ***	0.46 **
			Small insects	298	99	0.73 ***	0.24 **
			Seeds	33	15	0.08	0.04
Beans (snap, dried)	0.5	4 (ns[1])	Short grass	265	94	0.65 ***	0.23 **
			Small insects	149	50	0.37 **	0.12 *
			Seeds	17	8	0.04	0.02
Potatoes, Broccoli, Brussel sprouts, Cabbage, Cauliflower, Onions	0.75	3 (7)	Short grass	357	126	0.88 ***	0.31 **
			Small insects	201	67	0.50 ***	0.17 *
			Seeds	22	10	0.05	0.02
Celery, Peppers, Parsley, Cucumber, Eggplant, Spinach	0.5	3 (7 or ns[1])	Short grass	238	84	0.59 ***	0.21 **
			Small insects	134	47	0.33 **	0.12 *
			Seeds	15	7	0.04	0.02

when not specified (ns) on product labels, an application interval of 7 days is assumed

*** exceeds acute high risk (0.5), acute restricted use (0.2), and acute endangered species (0.1) LOC's

** exceeds acute restricted use and acute endangered species LOC's

* exceeds acute endangered species LOC

Table 61. Mammalian Acute Risk Quotients for Foliar Applications on Field Crops, Based on a Gray-tailed Vole LC50 of 406 ppm							
Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Max. EEC (ppm)	Mean EEC (ppm)	Acute RQ (Max. EEC/ LC50)	Acute RQ (Mean EEC/ LC50)
Cotton (conventional appl.)	0.5	12 (ns[1])	Short grass	306	108	0.75 ***	0.27 **
			Small insects	172	57	0.42 **	0.14 *
			Seeds	19	9	0.05	0.02
Cotton (CA, AZ) (conv. appl.)	0.75	8 (ns[1])	Short grass	452	160	1.11 ***	0.39 **
			Small insects	254	85	0.63 ***	0.21 **
			Seeds	28	13	0.07	0.03
Cotton (ULV appl.)	0.25	12 (ns[1])	Short grass	153	54	0.38 **	0.13 *
			Small insects	86	29	0.21 **	0.07
			Seeds	10	5	0.02	0.01
Alfalfa	0.75	2/cutting (10)	Short grass	269	95	0.66 ***	0.23 **
			Small insects	151	53	0.37 **	0.13 *
			Seeds	17	8	0.03	0.02
Soybeans	0.75	2 (ns[1])	Short grass	290	103	0.71 ***	0.25 **
			Small insects	163	58	0.40 **	0.14 *
			Seeds	18	8	0.04	0.02
Sugarcane	0.75	5 (21)	Short grass	233	83	0.57 ***	0.20 **
			Small insects	131	44	0.32 **	0.11 *
			Seeds	15	7	0.03	0.01
Wheat, Barley, Rye, Oats	0.5	1	Short grass	120	42	0.30 **	0.10 *
			Small insects	67	24	0.17 *	0.06
			Seeds	8	4	0.02	0.01

when not specified (ns) on product labels, an application interval of 7 days is assumed
*** exceeds acute high risk (0.5), acute restricted use (0.2), and acute endangered species (0.1) LOC's
** exceeds acute restricted use and acute endangered species LOC's
* exceeds acute endangered species LOC

Herbivorous mammals: Based on maximum EEC's on short grass, the acute high risk LOC is exceeded for all use sites except blackberries, boysenberries, loganberries, raspberries, and small grain crops. The restricted use and endangered species LOC's are exceeded for all use sites. The largest RQ's are for pecans (RQ = 2.34); tomatoes, apples, crabapples, pears, and quince (RQ's = 1.96); citrus (RQ = 1.90); and walnuts and filberts (RQ's = 1.79). The restricted use and endangered species LOC's are exceeded for all use sites when the RQ is based on maximum EECs on short grass.

Based on mean EEC's on short grass, the high risk LOC is exceeded for apples, crabapples, pears, quince, citrus, pecans, walnuts, filberts, pistachios, and tomatoes. The restricted use LOC is exceeded for all use sites except blackberries, boysenberries, loganberries, raspberries, and small grain crops. The endangered species LOC is exceeded for all use sites when the RQ is based on mean EECs on short grass.

Insectivorous mammals: Based on maximum EEC's on small insects, the acute high risk LOC is exceeded for cotton (conventional application, California and Arizona), apples, crabapples, pears, quince, citrus, plums, prunes, peaches, apricots, nectarines, cranberries, grapes, all nut crops, tomatoes, artichokes, black-eyed peas, potatoes, broccoli, brussels sprouts, cabbage, cauliflower, and onions. The restricted use LOC is exceed for all use sites except small grain crops. The endangered species LOC is exceeded for all use sites.

Based on mean EECs on small insects, the restricted use LOC is exceeded for cotton (conventional application, California and Arizona), apples, crabapples, pears, quince, citrus, plums, prunes, peaches, apricots, nectarines, all nut crops, tomatoes, artichokes, and black-eyed peas. The endangered species LOC is exceeded for all sites except cotton (ULV application only), blackberries, boysenberries, loganberries, raspberries, and small grain crops. The acute high risk LOC is not exceeded for any use site when the RQ is based on mean EEC's on small insects.

Granivorous mammals: Based on maximum EECs on seeds, the endangered species LOC is exceeded for apples, crabapples, pears, quince, citrus, tomatoes, pecans, walnuts, and filberts. The high risk and restricted use LOC's are not exceeded for any use site. No LOC's are exceeded when the RQ is based on mean EEC's on seeds.

The Agency's presumption of acute high risk to small mammals is supported by field and pen studies. Carcasses of small mammals containing azinphos methyl residues were collected after spray blast applications in Washington and Michigan apple orchards. As discussed previously for birds, the predicted EEC's upon which the risk quotients are based appear to be realistic in the field. The pen studies in Oregon also indicate the potential adverse effects of azinphos methyl on small mammal populations. Populations of gray-tailed voles were depressed at single applications of 1.5 lb ai/acre or more on alfalfa in one study. Although populations recovered after four weeks, the authors speculated that adverse effects resulting from multiple applications would likely be even more pronounced and prolonged than those observed from a single application. In a subsequent study, vole densities in enclosures treated at 3.25 lb ai/acre remained depressed for $\geq$ 6 weeks. The authors noted that a single application of azinphos methyl probably would not have long-term impacts on gray-tailed vole populations, but less highly fecund species might not recover as quickly.

The chronic risk quotients for foliar applications of azinphos methyl are tabulated separately below for fruit crops, nut crops, vegetable crops, and field crops.

Table 62. Mammalian Chronic Risk Quotients for Foliar Applications on Fruit Crops, Based on a Laboratory Rat NOAEC of 5 ppm

Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Item	Avg. Max. EEC (ppm)	Avg. Mean EEC (ppm)	Chronic RQ (Max. EEC/ NOAEC)	Chronic RQ (Mean EEC/ NOAEC)
Apples, Crabapples, Pears, Quince	1.5	4 (7)	Short grass	495	175	99 +	35 +
			Insects	262	87	52 +	17 +
			Seeds	41	19	8 +	4 +
Citrus	2	2 (ns[2])	Short grass	509	180	102 +	36 +
			Insects	269	89	54 +	18 +
			Seeds	42	20	8 +	4 +
Plums, Prunes (eastern)	1.5	2 (10)	Short grass	330	117	66 +	23 +
			Insects	175	58	35 +	12 +
			Seeds	27	13	5 +	3 +
Peaches, Apricots, Nectarines (eastern)	1.125	3 (14)	Short grass	205	73	41 +	15 +
			Insects	109	36	22 +	7 +
			Seeds	17	8	3 +	2 +
Cranberries, Grapes	1	3 (14)	Short grass	203	72	41 +	14 +
			Insects	114	38	23 +	8 +
			Seeds	13	6	3 +	1 +
Blueberries	0.75	3 (10)	Short grass	187	66	37 +	13 +
			Insects	99	33	20 +	7 +
			Seeds	15	7	3 +	1 +
Strawberries	0.5	4 (5)	Short grass	196	69	39 +	14 +
			Insects	104	35	21 +	7 +
			Seeds	16	7	3 +	1 +
Cherries (eastern)	0.75	4 (14)	Short grass	155	55	31 +	11 +
			Insects	87	29	17 +	6 +
			Seeds	10	5	2 +	1 +
Melons	0.5	3 (5)	Short grass	172	61	34 +	12 +
			Insects	97	32	19 +	6 +
			Seeds	11	5	2 +	1 +
Pomegranate	1	2 (30)	Short grass	108	38	22 +	8 +
			Insects	61	20	12 +	4 +
			Seeds	7	3	1 +	0.6
Blackberries, Boysenberries, Loganberries, Raspberries	0.5	2 (ns[2])	Short grass	127	45	25 +	9 +
			Insects	71	24	14 +	5 +
			Seeds	8	4	2 +	0.8

[1] RQ = EEC (ppm) ÷ LC50)

[2] when not specified (ns) on product labels, an application interval of 7 days is assumed

Table 63. Mammalian Chronic Risk Quotients for Foliar Applications on Nut Crops, Based on a Laboratory Rat NOAEC of 5 ppm

Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Item	Avg. Max. EEC (ppm)	Avg. Mean EEC (ppm)	Chronic RQ (Max. EEC/ NOAEC)	Chronic RQ (Mean EEC/ NOAEC)
Pecans	2	3 (7)	Short grass	599	212	120 +	42 +
			Insects	317	106	63 +	21 +
			Seeds	49	23	10 +	5 +
Walnuts, Filberts	2	3 (14)	Short grass	394	139	79 +	28 +
			Insects	209	69	42 +	14 +
			Seeds	32	15	6 +	3 +
Almonds	2	2 (30)	Short grass	216	76	43 +	15 +
			Insects	114	38	23 +	8 +
			Seeds	18	8	4 +	2 +

[1] RQ = EEC (ppm) ÷ LC50)

Table 64. Mammalian Chronic Risk Quotients for Foliar Applications on Vegetable Crops, Based on a Laboratory Rat NOAEC of 5 ppm							
Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Avg. Max. EEC (ppm)	Avg. Mean EEC (ppm)	Chronic RQ (Avg. Max. EEC/NOAEC)	Chronic RQ (Avg. Mean EEC/NOAEC)
Tomatoes	1.5	4 (7)	Short grass Small insects Seeds	495 262 41	175 87 19	99 + 52 + 8 +	35 + 17 + 4 +
Artichokes	1.5	3 (14)	Short grass Small insects Seeds	304 171 19	108 57 9	61 + 34 + 4 +	22 + 12 + 2 +
Black-eyed peas	1	4 (ns[1])	Short grass Small insects Seeds	333 187 21	118 62 9	67 + 37 + 4 +	24 + 12 + 2 +
Beans (snap, dried)	0.5	4 (ns[1])	Short grass Small insects Seeds	166 93 10	59 31 5	33 + 19 + 2 +	12 + 6 + 1 +
Potatoes, Broccoli, Brussel sprouts, Cabbage, Cauliflower, Onions	0.75	3 (7)	Short grass Small insects Seeds	225 119 18	80 39 8	45 + 24 + 4 +	16 + 8 + 2 +
Celery, Peppers, Parsley, Cucumber, Eggplant, Spinach	0.5	3 (7 or ns[1])	Short grass Small insects Seeds	150 84 9	53 28 4	30 + 17 + 2 +	11 + 6 + <1

[1] when not specified (ns) on product labels, an application interval of 7 days is assumed
+ exceeds the chronic LOC (1)

Table 65. Mammalian Chronic Risk Quotients for Foliar Applications on Field Crops, Based on a Laboratory Rat NOAEC of 5 ppm							
Site	Appl. Rate (lb ai/A)	No. Appl./ Interval (days)	Food Items	Avg. Max. EEC (ppm)	Avg. Mean EEC (ppm)	Chronic RQ (Avg. Max. EEC/NOAEC)	Chronic RQ (Avg. Mean EEC/NOAEC)
Cotton (conventional appl.)	0.5	12 (ns[1])	Short grass Small insects Seeds	206 116 13	73 39 6	41 + 23 + 3 +	15 + 8 + 1 +
Cotton (CA, AZ) (conv. appl.)	0.75	8 (ns[1])	Short grass Small insects Seeds	304 171 19	108 57 9	61 + 34 + 4 +	22 + 12 + 2 +
Cotton (ULV appl.)	0.25	12 (ns[1])	Short grass Small insects Seeds	103 55 8	36 18 4	21 + 11 + 2 +	7 + 4 + <1
Alfalfa	0.75	2/cutting (10)	Short grass Small insects Seeds	165 93 10	58 31 5	33 + 19 + 2 +	12 + 6 + 1 +
Soybeans	0.75	2 (ns[1])	Short grass Small insects Seeds	191 107 12	68 36 6	38 + 21 + 2 +	14 + 7 + 1 +
Sugarcane	0.75	5 (21)	Short grass Small insects Seeds	114 60 9	40 20 4	23 + 12 + 2 +	8 + 4 + <1

[1] when not specified (ns) on product labels, an application interval of 7 days is assumed
+ exceeds the chronic LOC (1)

The mammalian chronic LOC is exceeded for herbivores, insectivores, and granivores for all fruit, nut, vegetable, and field crops when EEC's are determined from either maximum or mean initial EEC's and averaged across the period of application, which is based on the number of applications and the interval between applications.

iii. Insects

EFED does not assess risk to non-target insects. Results of acceptable studies are used for recommending appropriate label precautions. However, because azinphos methyl is highly toxic to honey bees, wasps, and beetles, and displays residual toxicity, any non-target insects present in treatment areas are likely at high risk. High pollinator use is associated with many of the crops (e.g., orchards, alfalfa) treated with azinphos methyl.

Exposure and Risk to Non-target Aquatic Animals

Summary

Azinphos methyl poses high acute and chronic risks to all aquatic organisms. Based on the most sensitive species and the TIER II estimated concentrations, azinphos methyl exceeds the level of concern for both non-endangered and endangered freshwater fish and invertebrates and marine/estuarine fish and invertebrates. Although a risk assessment was not conducted on amphibians, results from toxicity data indicate that azinphos methyl has acute effects (mortality) to amphibians at 109 ppb.

Risk to Non-target Aquatic Animals

This assessment is based on the Tier 2 EEC's discussed in the water resources section.

i. Freshwater Fish

Table 66 Risk Quotients (RQ) for Freshwater Fish Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Apples and Crabapples.

Product /application rate	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	60 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ
Guthion WP's**	Rainbow trout	2.9	0.23	13.9	9.0	4.79	39.13
	Brook trout	1.2	N/A	13.9	N/A	11.58	N/A
	Bluegill sunfish	4.1	N/A	13.9	N/A	3.39	N/A

** Includes all four Guthion wettable powder (WP) formulations, 50% WP, Solupak 50% WP, 35% WP, and Solupak 35% WP, not registered for use on quince.

Table 67. Risk Quotients (RQ) for Freshwater Fish Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Pears.

Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	60 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ
Guthion WP's*	Rainbow trout	2.9	0.23	8.9	4.9	3.07	21.30
	Brook trout	1.2	N/A	8.9	N/A	7.42	N/A

Table 67. Risk Quotients (RQ) for Freshwater Fish Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Pears.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	60 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ
	Bluegill sunfish	4.1	N/A	8.9	N/A	2.17	N/A

* Includes all four Guthion wettable powder (WP) formulations, 50% WP, Solupak 50% WP, 35% WP, and Solupak 35% WP, not registered for use on quince.

Table 68. Risk Quotients (RQ) for Freshwater Fish Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Almonds.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	60 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ
Guthion 50% WP's*	Rainbow trout	2.9	0.23	8.3	4.8	2.86	20.87
	Brook trout	1.2	N/A	8.3	N/A	6.92	N/A
	Bluegill sunfish	4.1	N/A	8.3	N/A	2.02	N/A
Guthion 35% WP's, 2L**	Rainbow trout	2.9	0.23	8.0	4.6	2.76	20.00
	Brook trout	1.2	N/A	8.0	N/A	6.67	N/A
	Bluegill sunfish	4.1	N/A	8.0	N/A	1.95	N/A

* Includes two wettable powder formulations; 50% WP and Solupak.
** Includes three formulations; 35% WP, Solupak 35% WP, and 2L

Table 69. Risk Quotients (RQ) for Freshwater Fish Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Filberts.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	60 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ
All Guthions	Rainbow trout	2.9	0.23	9.3	5.7	3.21	24.78
	Brook trout	1.2	N/A	9.3	N/A	7.75	N/A
	Bluegill sunfish	4.1	N/A	9.3	N/A	2.27	N/A

Table 70. Risk Quotients (RQ) for Freshwater Fish Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Walnuts.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	60 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ
All Guthions	Rainbow trout	2.9	0.23	12.0	7.3	4.14	31.74
	Brook trout	1.2	N/A	12.0	N/A	10.00	N/A
	Bluegill sunfish	4.1	N/A	12.0	N/A	2.93	N/A

Table 71. Risk Quotients (RQ) for Freshwater Fish Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Cotton. *This product has been voluntarily canceled.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	60 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ
Guthion 3F	Rainbow trout	2.9	0.23	87.8	49.5	30.28	215.22
	Brook trout	1.2	N/A	87.8	N/A	73.17	N/A
	Bluegill sunfish	4.1	N/A	87.8	N/A	21.41	N/A
Guthion 3F, 6 applications	Rainbow trout	2.9	0.23	48.8	27.5	16.83	119.57
	Brook trout	1.2	N/A	48.8	N/A	40.67	N/A
	Bluegill sunfish	4.1	N/A	48.8	N/A	11.90	N/A

Table 72. Risk Quotients (RQ) for Freshwater Fish Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Potatoes.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	60 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ
All Guthions	Rainbow trout	2.9	0.23	13.6	7.6	4.69	33.04
	Brook trout	1.2	N/A	13.6	N/A	11.33	N/A
	Bluegill sunfish	4.1	N/A	13.6	N/A	3.32	N/A

Table 73. Risk Quotients (RQ) for Freshwater Fish Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Cherries.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	60 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ
Guthion WP's	Rainbow trout	2.9	0.23	10.7	6.7	3.69	29.13
	Brook trout	1.2	N/A	10.7	N/A	8.92	N/A
	Bluegill sunfish	4.1	N/A	10.7	N/A	2.61	N/A

Table 74. Risk Quotients (RQ) for Freshwater Fish Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Peaches.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	60 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ
All Guthions	Rainbow trout	2.9	0.23	40.6	25.5	14.00	110.87
	Brook trout	1.2	N/A	40.6	N/A	33.83	N/A
	Bluegill sunfish	4.1	N/A	40.6	N/A	9.90	N/A

Table 75. Risk Quotients (RQ) for Freshwater Fish Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Plums.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	60 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ
All Guthions	Rainbow trout	2.9	0.23	8.0	4.6	2.76	20.00
	Brook trout	1.2	N/A	8.0	N/A	6.67	N/A
	Bluegill sunfish	4.1	N/A	8.0	N/A	1.95	N/A

Discussion

Based on the most sensitive acceptable warmwater (Bluegill Sunfish) and coldwater (Rainbow and Brook Trout) freshwater fish species tested and the Tier 2 estimated environmental concentrations, azinphos methyl poses high acute and chronic risk to both non-endangered and endangered freshwater fish species on all of the above use sites.

ii. Freshwater Invertebrates

Table 76. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Apples and Crabapples.

Product /application rate	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
Guthion WP's*	*Daphnia magna*	1.13	0.25	13.9	11.0	12.30	44.00
	Gammarus fasciatus	0.16	N/A	13.9	N/A	86.88	N/A

* Includes all four Guthion wettable powder (WP) formulations, 50% WP, Solupak 50% WP, 35% WP, and Solupak 35% WP, not registered for use on quince.

Table 77. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Pears.

Product	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
Guthion WP's*	*Daphnia magna*	1.13	0.25	8.9	6.8	7.88	27.20
	Gammarus fasciatus	0.16	N/A	8.9	N/A	55.63	N/A

* Includes all four Guthion wettable powder (WP) formulations, 50% WP, Solupak 50% WP, 35% WP, and Solupak 35% WP, not registered for use on quince.

Table 78. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Almonds.

Product	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
Guthion 50% WPs*	*Daphnia magna*	1.13	0.25	8.3	6.2	7.35	24.80
	Gammarus fasciatus	0.16	N/A	8.3	N/A	51.88	N/A
Guthion 35% WP's, 2L**	*Daphnia magna*	1.13	0.25	8.0	5.9	7.08	23.60
	Gammarus fasciatus	0.16	N/A	8.0	N/A	50.00	N/A

Table 78. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Almonds.							
Product	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
* Includes two wettable powder formulations; 50% WP and Solupak. ** Includes three formulations; 35% WP, Solupak 35% WP, and 2L							

Table 79. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Filberts.							
Product	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
All Guthions	*Daphnia magna*	1.13	0.25	9.3	7.1	8.23	28.40
	Gammarus fasciatus	0.16	N/A	9.3	N/A	58.13	N/A

Table 80. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier Aquatic EEC's for Bayer Corporation's Products Applied to Walnuts.							
Product	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
All Guthions	*Daphnia magna*	1.13	0.25	12.0	9.1	10.62	36.40
	Gammarus fasciatus	0.16	N/A	12.0	N/A	75.00	N/A

Table 81. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Cotton. *This product has been voluntarily canceled.							
Product	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
Guthion 3F	*Daphnia magna*	1.13	0.25	87.8	69.2	77.70	276.80
	Gammarus fasciatus	0.16	N/A	87.8	N/A	548.75	N/A
Guthion 3F, 6 applications	*Daphnia magna*	1.13	0.25	48.8	40.5	43.19	162.00

Table 81. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Cotton. *This product has been voluntarily canceled.							
Product	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
	Gammarus fasciatus	0.16	N/A	48.8	N/A	305.00	N/A

Table 82. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Potatoes.							
Product	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
All Guthions	*Daphnia magna*	1.13	0.25	13.6	10.4	12.04	41.60
	Gammarus fasciatus	0.16	N/A	13.6	N/A	85.00	N/A

Table 83. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier 2 Aquatic EECs[1] for Bayer Corporation's Products applied to Cherries.							
Product	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
Guthion 3F	*Daphnia magna*	1.13	0.25	10.4	8.3	9.20	33.20
	Gammarus fasciatus	0.16	N/A	10.4	N/A	65.00	N/A
Guthion WP's	*Daphnia magna*	1.13	0.25	10.7	8.6	9.47	34.40
	Gammarus fasciatus	0.16	N/A	10.7	N/A	66.88	N/A

Table 84. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Peaches.							
Product	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
All Guthions	*Daphnia magna*	1.13	0.25	40.6	33.5	35.93	134.00

Table 84. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Peaches.							
Product	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
	Gammarus fasciatus	0.16	N/A	40.6	N/A	253.75	N/A

Table 85. Risk Quotients (RQ) for Freshwater Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Plums.							
Product	Species	EC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	21 Day EEC (ppb)	Acute RQ (48-hr)	Chronic RQ (21-day)
All Guthions	*Daphnia magna*	1.13	0.25	8.0	5.9	7.08	23.60
	Gammarus fasciatus	0.16	N/A	8.0	N/A	50.00	N/A

Discussion

Based on the most sensitive acceptable freshwater invertebrate species (*Gammarus fasciatus* and *Daphnia magna*) tested and the TIER II estimated environmental concentrations, azinphos methyl poses high acute and chronic risk respectively to both non-endangered and endangered freshwater invertebrate species on all of the above use sites.

iii. Estuarine and Marine Animals

Table 86. Risk Quotients (RQ) for Estuarine and Marine Fish and Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Apples and Crab Apples.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	90 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ (60-day)
Guthion WP's*	Sheepshead minnow	2.7	0.2	13.9	7.7	5.15	38.50
	Mysid shrimp	0.21	N/A	13.9	N/A	66.19	N/A

Table 86. Risk Quotients (RQ) for Estuarine and Marine Fish and Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Apples and Crab Apples.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	90 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ (60-day)

* Includes all four Guthion wettable powder (WP) formulations, 50% WP, Solupak 50% WP, 35% WP, and Solupak 35% WP, not registered for use on quince.

Table 87. Risk Quotients (RQ) for Estuarine and Marine Fish and Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Pears.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	90 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ (60-day)
Guthion WP's*	Sheepshead minnow	2.7	0.2	8.9	4.8	3.30	24.00
	Mysid shrimp	0.21	N/A	8.9	N/A	42.38	N/A

* Includes all four Guthion wettable powder (WP) formulations, 50% WP, Solupak 50% WP, 35% WP, and Solupak 35% WP, not registered for use on quince.

Table 88. Risk Quotients (RQ) for Estuarine and Marine Fish and Invertebrates Using Tier 2 Aquatic EEC,s for Bayer Corporation's Products Applied to Almonds.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	90 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ (60-day)
Guthion 50% WP's*	Sheepshead minnow	2.7	0.2	8.3	3.9	3.07	19.50
	Mysid shrimp	0.21	N/A	8.3	N/A	39.52	N/A
Guthion 35% WP's, 2L**	Sheepshead minnow	2.7	0.2	8.0	3.8	2.96	19.00
	Mysid shrimp	0.21	N/A	8.0	N/A	38.10	N/A

* Includes two wettable powder formulations; 50% WP and Solupak.
** Includes three formulations; 35% WP, Solupak 35% WP, and 2L.

Table 89. Risk Quotients (RQ) for Estuarine and Marine Fish and Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Filberts.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	90 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ (60-day)
All Guthions	Sheepshead minnow	2.7	0.2	9.3	4.8	3.44	24.00
	Mysid shrimp	0.21	N/A	9.3	N/A	44.29	N/A

Table 90. Risk Quotients (RQ) for Estuarine and Marine Fish and Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Walnuts.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	90 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ (60-day)
All Guthions	Sheepshead minnow	2.7	0.2	12.0	6.2	4.44	31.00
	Mysid shrimp	0.21	N/A	12.0	N/A	57.14	N/A

Table 91. Risk Quotients (RQ) for Estuarine and Marine Fish and Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Cotton. *This product has been voluntarily canceled.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	90 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ (60-day)
Guthion 3F	Sheepshead minnow	2.7	0.2	87.8	40.4	32.52	202.00
	Mysid shrimp	0.21	N/A	87.8	N/A	418.10	N/A
Guthion 3F, 6 applications	Sheepshead minnow	2.7	0.2	48.8	21.8	18.07	109.00
	Mysid shrimp	0.21	N/A	48.8	N/A	232.38	N/A

Table 92. Risk Quotients (RQ) for Estuarine and Marine Fish and Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Potatoes.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	90 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ (60-day)
All Guthions	Sheepshead minnow	2.7	0.2	13.6	6.2	5.04	31.00
	Mysid shrimp	0.21	N/A	13.6	N/A	64.76	N/A

Table 93. Risk Quotients (RQ) for Estuarine and Marine Fish and Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Cherries.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	90 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ (60-day)
Guthion WP's	Sheepshead minnow	2.7	0.2	10.7	5.6	3.96	28.00
	Mysid shrimp	0.21	N/A	10.7	N/A	50.95	N/A

Table 94. Risk Quotients (RQ) for Estuarine and Marine Fish and Invertebrates Using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Peaches.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	90 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ (60-day)
All Guthions	Sheepshead minnow	2.7	0.2	40.6	21.2	15.04	106.00
	Mysid shrimp	0.21	N/A	40.6	N/A	193.33	N/A

Table 95. Risk Quotients (RQ) for Estuarine and Marine Fish and Invertebrates using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Plums.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	90 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ (60-day)
All Guthions	Sheepshead minnow	2.7	0.2	8.0	3.8	2.96	19.00
	Mysid shrimp	0.21	N/A	8.0	N/A	38.10	N/A

Table 96. Risk Quotients (RQ) for Estuarine and Marine Fish and Invertebrates using Tier 2 Aquatic EEC's for Bayer Corporation's Products Applied to Sugarcane.							
Product	Species	LC_{50} (ppb)	NOAEC (ppb)	Maximum EEC (ppb)	90 Day EEC (ppb)	Acute RQ (96-hr)	Chronic RQ (60-day)
All Guthions	Sheepshead minnow	2.7	0.2	22.1	12.5	8.19	62.50
	Mysid shrimp	0.21	N/A	22.1	N/A	105.24	N/A

Discussion

Based on the most sensitive estuarine/marine fish (sheepshead minnow) and invertebrate species (Mysid shrimp) tested and the TIER II estimated environmental concentrations, azinphos methyl poses high acute and chronic risk to both non-endangered and endangered estuarine/marine fish and high acute risk to non-endangered estuarine/marine invertebrate species on all of the above use sites.

Endangered Species

The Agency has developed a program (the "Endangered Species Protection Program") to identify pesticides whose use may cause adverse impacts on endangered and threatened species, and to implement mitigation measures that will eliminate the adverse impacts. At present, the program is being implemented on an interim basis as described in a Federal Register notice (54 FR 27984-28008, July 3, 1989), and is providing information to pesticide users to help them protect these species on a voluntary basis. As currently planned, the final program will call for label modifications referring to required limitations on pesticide uses, typically as depicted in county-specific bulletins or by other site-specific mechanisms as specified by state partners. A final program, which may be altered from the interim program, will be described in a future Federal Register notice. The Agency is not imposing label modifications at this time through the RED. Rather, any requirements for product use modifications will occur in the future under the Endangered Species Protection Program.

Attached as appendix II are listed the endangered fish and aquatic invertebrates according to crop. These lists were based on the EFED Endangered Species Data Base which was last updated in October of 1992.

5. Risk Characterization

Risk characterization is a qualitative assessment of risks that expands on the environmental fate and ecological effects risk assessments. It includes discussions of other factors that may affect risk but were not considered in the quantitative risk assessments.

Azinphos methyl exceeds acute and chronic levels of concern for aquatic and terrestrial organisms at all use sites. Based on the number and magnitude of incidents in EFED's Incident Data Base System, there is considerable documentation that azinphos methyl kills aquatic organisms when applied at registered use sites. There are more adverse incident data for aquatic environments (fish kills) associated with azinphos methyl than for any other chemical in the EFED Incident Data Base System (approximately 50% of the database concerns azinphos methyl). There are 131 incidents over which hundreds of thousands of fish were killed. Kills of birds and reptiles have also been reported with azinphos methyl use. Mortality of birds and mammals was demonstrated in terrestrial field and pen studies. These findings are supported by exceedance of levels of concern for acute risks to birds and small mammals. Exceedance of the chronic level of concern for birds and small mammals for the major use sites suggests adverse reproductive effects are highly likely when these animals are exposed to repeated sublethal doses. Reproduction might also be impacted due to behavioral effects (e.g., nest desertion) on adults and subsequent starvation or predation of unattended eggs and nestlings. Concern for insect pollinators also is warranted based on the high acute and residual toxicity of azinphos methyl to honey bees. Most treatment sites (e.g., orchards, alfalfa) are highly used by insect pollinators. Additionally, EFED is concerned about potential secondary toxicity to animals scavenging dead fish and aquatic invertebrates; scavenging by birds and other terrestrial organisms has been observed at fish kills.

Like other organophosphate pesticides, azinphos methyl exhibits high acute toxicity due to irreversible inhibition of cholinesterase enzymes. Significant inhibition of brain and blood cholinesterase has been observed in rats administered azinphos methyl at doses as low as 1mg ai/kg (MRID 04336031). As with humans, exposure of wildlife to cholinesterase inhibiting pesticides disrupts normal neuromuscular control. Death can occur rapidly, due primarily to respiratory failure. Organophosphate exposure can also result in chronic effects in animals such as reproduction impairment and delayed neuropathy.

Major uses

According to current BEAD estimates, apples alone represented over 40% of the total use. In order of decreasing use, the major use crops for azinphos methyl are apples, cotton, almonds, pears, peaches, walnuts, potatoes, sugarcane, blueberries, plums, and cranberries. Together, these crops represent 91% of the azinphos methyl usage. Around 2 million pounds are applied per year on average with a maximum of 5 million pounds (Neil Anderson, personal communication to Barry O'Keefe, 1999).

Environmental Fate

Azinphos methyl is moderately persistent but not sufficiently mobile under most conditions to be of concern in groundwater. The exception to this may be in karst areas or where preferential flow is the dominant transport mechanism. In the Pesticides in Ground Water Database, there were 16 detections of azinphos methyl listed for the state of Virginia, some of which exceeded 75 $\mu g \cdot L^{-1}$. Although there are uncertainties associated with this monitoring data we have no reason to doubt their validity. There are strong connections between surface water and ground water in karst regions and recharge of groundwater is very rapid in these areas.

In general it appears to be more persistent than most other foliarly applied organophosphates. It does move to surface waters through both spray drift and runoff. Identified environmental degradates are substantially less toxic than the parent.

Aquatic Organisms

The aquatic levels of concern are exceeded for marine/estuarine and freshwater fish and aquatic invertebrates. There is a large number of incidents associated with the use of azinphos methyl (refer to section 6 and Appendix I) on major crops. When Azinphos-methyl usage covers a large proportion of a watershed catastrophic fish kills *will* occur as was seen with sugarcane and cotton use.

The majority of the fish kill incidents were related to sugarcane and cotton sites. The preponderance of incidents on these sites is probably due to the proximity of these crops to water and intense and frequent rainfalls in addition to its high toxicity. There were also incidents for orchard use sites. However, there were fewer incidents for these sites than for cotton and sugarcane even though more azinphos methyl is used on orchards.

In general, aquatic exposure was higher for row crops (cotton and sugar cane) than for orchard crops. Several factors are responsible for this. First, the climate in the Southeast where the row crops are grown has more frequent and intense rainfall resulting in greater runoff loading of azinphos methyl. This factor also causes eastern orchards to have higher associated risks than western orchards. The pattern of rainfall also is a factor. Precipitation in the West tends to fall in the winter when the crops are not actively growing. The exception to this is for dormant applications to orchards such as almonds. These applications are made during the rainy season on the west coast and are therefore associated with greater runoff potential. Secondly, row crops tend to get aerial applications while orchards receive spray blast applications. Spray blast tends to have reduced drift because of large droplet sizes and better canopy interception. Again, dormant applications are an exception as the leaves are off the trees so there is greatly decreased canopy interception. A third factor is that general agronomic practice keeps the floor of most orchards at least partially covered in grass. This greatly reduces runoff compared to that from row crops. Another factor is the proximity of the fields or orchards to water. In some cases, crops are typically grown in close association with water bodies in north central Washington, but in other places such as Kent and Iona Counties in Michigan and Ulster and Clinton Counties in New York, there is no such association (Crabtree *et al.*, 1997).

Azinphos methyl has been detected at incident sites in concentrations in excess of the fish and aquatic invertebrates LC50's and chronic NOAEC's. The LC50s for aquatic invertebrates and fish are both approximately 1 ppb and the chronic NOAEC's were 0.2 ppb. Based on the similar toxicity values, it is also likely that aquatic invertebrates are similarly impacted, even though mortality effects to aquatic invertebrates are rarely detected. Population reduction in aquatic invertebrates may result in food shortages for organisms higher in the food chain.

The similarity in the acute and chronic endpoints does not eliminate the possibility of chronic effects. Chronic effects, such as reproduction or growth, also may not be seen initially at an incident site. However, when a large number of fish die the population may have difficulty recovering. In addition, significant secondary effects may be caused by decay of the large number of fish killed.

Terrestrial Organisms

The presumptions of acute risk are demonstrated by findings from field and pen studies. In addition, the acute risk levels of concern for avian and mammalian herbivores and insectivores are exceeded 1- to 4-fold for all fruit, vegetable, nut, and field crops. Applications of azinphos methyl at maximum labeled use rates in apple orchards in Michigan and Washington resulted in documented mortality of a variety of birds and small mammals. These findings are significant, because about 40% of all azinphos methyl used is applied in apple orchards. According to USDA/NASS, approximately 350,800 acres of apples were grown in the eight major apple-growing states (WA, MI, NY, CA, PA, OR, NJ, SC) in 1997, and azinphos methyl was applied to 82% of the acreage. As indicated by the field studies in Washington and Michigan, apple orchards are inhabited by a variety of birds and mammals. Forty-one species of birds and 11 wild mammal species utilized the 8 treated apple orchards (11 - 54 acres each) in Washington, and 36 bird species and 17 mammal species were recorded within the 8 treated orchards in Michigan. Based on this information, EFED presumes that use of azinphos methyl in apple and other orchards poses a high acute risk to birds and mammals.

Pen studies in treated alfalfa enclosures demonstrated short-term population effects on survival of voles, deer mice, and northern bobwhite chicks following single applications of azinphos methyl. Multiple applications also had short-term but additive effects on vole survival. Although vole populations tended to recover to control levels within one to several weeks after exposure to azinphos methyl, the researchers speculated that effects could be more pronounced and prolonged for species with less recovery potential than the highly fecund gray-tailed vole. Collectively, the field and pen studies support the presumptions of acute risk to birds and small mammals from registered uses of azinphos methyl.

The chronic level of concern was exceeded up to 47-fold for birds and as much as 99-fold for small mammals. Uncertainty exists in extrapolating results of reproductive studies from the laboratory to the field, and no reproductive field studies are available for azinphos methyl. However, the high exceedances of the level of concern strongly suggest that adverse reproductive effects are likely from chronic exposure. Because multiple applications are made at all azinphos methyl use sites, chronic exposure is likely for those birds and mammals that survive repeated acute exposure. Although exceedances were higher for mammals than birds for all uses, chronic risk in orchards is likely to be higher for birds than for mammals. Orchard application, which accounted for >75% of the total poundage of azinphos methyl in 1996, is predominately by air blast directed into the trees. Many species of birds are known to feed and nest in orchard trees. During the field study in Washington apple orchards, 41 bird species were recorded within the orchards, and nine species were observed nesting. As indicated in the laboratory reproductive studies, azinphos methyl may adversely effect egg production, embryo viability, and chick survival at low concentrations. Reproduction might also be impacted due to behavioral effects (e.g., nest desertion) on adults and subsequent starvation or predation of unattended eggs and nestlings.

EFED also is concerned that routes of exposure other than ingestion of contaminated food sources could be important in orchards. Dermal exposure may occur if birds contact wet residues remaining on tree foliage after air-blast application. In the Michigan field study, 14 species of birds were observed in treated orchards within 30 minutes of the azinphos methyl application, indicating a likelihood for dermal exposure. Both dermal and inhalation exposure of brooding adults and their young might occur if application is made when birds are nesting. Although adults may leave orchards as the application equipment approaches, nestlings and fledglings are unable to leave to avoid the spray; some adults also may not leave if attending nests at the time of application. Insufficient information exists to assess the significance of these exposure routes for azinphos methyl, but a laboratory study demonstrated that multiple pathways may be important driver. Secondary exposure and toxicity to predators and scavengers feeding on dead or dying birds, mammals, or aquatic organisms also may be important in some situations, but more information is needed to assess impacts to individuals and local populations of secondary consumers such as raptors and mammalian carnivores.

Below is a table summarizing acute and chronic risk quotients for birds and mammals for the major use sites.

Table 97. Summary of RQ's for Major Use Sites of Azinphos Methyl

Site	Food Group	Acute RQ's		Chronic RQ's	
		Birds	Mammals	Birds	Mammals
Apples, Pears	grazers	1.63	1.96	47	99
	insectivores	0.92	1.10	25	52
	granivores	0.10	0.12	4	8
Cotton	grazers	0.93	1.11	29	61
	insectivores	0.52	0.63	16	34
	granivores	<0.1	<0.1	2	4
Almonds	grazers	1.10	1.33	21	43
	insectivores	0.62	0.75	11	23
	granivores	<0.1	<0.1	2	4
Cherries	grazers	0.58	0.69	15	31
	insectivores	0.32	0.39	8	17
	granivores	0.04	0.04	<1	2
Peaches	grazers	0.84	1.00	20	41
	insectivores	0.47	0.57	10	22
	granivores	0.05	0.06	2	3
Walnuts	grazers	1.49	1.79	38	79
	insectivores	0.84	1.00	20	42
	granivores	0.09	0.11	3	6

APPENDIX I

AZINPHOS-METHYL (GUTHION) INCIDENTS

1) Terrestrial Incidents

Table 1: Azinphos methyl (Guthion) Terrestrial Incidents

Incident No./ Date	Species	Effect/#	Crop/ Misuse/ Application Method	St	Residue Analysis	
					Item	Conc. (ppm)
Comments						
I002508 8/10/95	Swallow Killdeer Mourning Doves Rabbit	killed/2 killed/5 killed/4 killed/2	agricultural area	AR	Rabbits	N/R
Guthion was used with Pirate 3SC, Jefferson Co., Treated area surrounded by cotton, soybeans, canal, and treeline. Reported by ASPB. This use was under a Sect. 18 for Pirate 3SC.						
I003439 05/04/96	birds	killed/ 13	alfalfa	CA	feathers GI tract alfalfa	3 16 17
Alfalfa residues 9 days after spray, Imperial Valley (CDFG)						
I003654-014 6/16/97	bees	N/R	orchards	NC	bees	2.0 & 16 ppm
The NCDA received bee kill incident on 6/16/93. Area orchard were treated. The pesticides that were found were Guthion, Methyl parathion and phosmet. NCDA could not identify which application caused the bee kill.						

Table 1: Azinphos methyl (Guthion) Terrestrial Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop/ Misuse/ Application Method**	**St**	**Residue Analysis**	
					Item	**Conc. (ppm)**
Comments						
I003654-017 8/13/93	bees	N/R	orchards	NC	bees	0.29 ppm Guthion 0.71 ppm methyl parathion 1.12 ppm phosmet
NCDA found Guthion, methyl parathion, and phosmet were found in bees. The surrounding orchards were treated with these compounds.						
I003826-014 6/20/95	bees	N/R	orchards	NC	bees	2.2 ppm Guthion 3.0 ppm methyl parathion 0.2 ppm Chlorpyrofo s
NCDA reported a bee kill on 6/20/95. The above chemical were found in bees. The NCDA were unable to determine which were responsible for the bee kill.						
I003826-107 7/6/94	bees	N/R	apple orchards	NC	vegetation	27 ppm
NCDA reported a bee kill 7/6/94. Pesticides that were applied methyl parathion, Phosmet, Guthion, chlorpyrofos, Captan, and endosulfan. Sevin (carbaryl) was found in bees at 0.08 ppm.						

Table 1: Azinphos methyl (Guthion) Terrestrial Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop/ Misuse/ Application Method**	**St**	**Residue Analysis**	
					Item	**Conc. (ppm)**
Comments						
I000363	bees	N/A	Aerial Application	AZ	N/A	N/A
This was the review of a video tape, Pesticides in Arizona, The Continuing Problem of Shame. Beekeepers: J. Smith, C. Emmons, & F. Carpenter. This video mentions Guthion in connection with bee kills in Arizona.						
I004054 8/10/96	horse	1	Cotton Aerial	MO	none	N/A
A 6(a)(2) incident report from Bayer Co. of 9/3/96 for Guthion 2L. Reported a horse exhibited "mild abdominal pain and colic, salivation, depression, general recumbent activity, hyperthermia, and musculoskeletal weakness". Horse recovered 10 days late. According to Bayer the incident was due to pesticide drift.						

2) Aquatic Incidents

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
I003439-001 05/04/96	fish	number of fish killed	Forest-Misuse (accidental) Aerial	AR	Pond water	16

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
Aerial application of Guthion 2S. Pond on Georgia Pacific property was accidentally over-sprayed. No specific number of dead fish were reported just that there was a number of dead fish. The incident was reported by Bayer Co.						
I005754-019 1973	fish	N/R	Alfalfa	CA	N/R	N/R
This incident occurred after a Guthion treated alfalfa field was irrigated. This was not confirmed by sample analysis						
I000687-001 I000769-001 07/04/93	catfish	killed/ 2000	almonds or walnuts	CA	water	0 to 4.9 ppb
This incident occurred in Glenn County, CA. Miles Corp. was notified of a fish kill occurred by the Glenn County Agricultural Commissioners Office. The fish kill occurred in an agricultural drain ditch that flows into the Sacramento River. Analysis of fish tissues were nor performed. Water analysis was done. The analyses found Guthion at 4.9 ppb and diazinon around 20 ppb. **I000769-001** According to the California Pesticide Investigation Report: "The California Department of Fish and Game feels that there is not enough evidence to substantiate the exact cause of this incident"						
I000769-001 07/26/93	catfish and bass	2000 fish including 1000 catfish and bass	almonds or walnuts	CA	water	Guthion ND (MDL =0.5 ppb) to 4.9 ppb Diazinon 0.68 to 4.9 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
The report by the State of California for the fish kill incident (see above) I000687 that occurred in Glenn Co. had been issued and submitted under the incident No. I000769. The report states; "An anhydrous ammonia (fertilizer) application was being made at the top end of the fish kill. During the course of the application the lift pump located on the drain shut down and anhydrous ammonia may have been syphoned from the application cite back to the drain back to the drain. There was no air gap or back flow prevention device on the pump system. Anhydrous ammonia could kill fish by direct contact or cause an algal bloom to occur resulting in oxygen depletion in the drain. Insecticides (diazinon and Guthion) were being applied extensively to orchards in the area prior to and at the time of the fish kill. The levels of insecticides three to four days after the fish kill indicate that pesticides were present but these levels were not at levels that would normally kill fish (CDFG). The CDFG feels that there is not enough evidence to substantiate the exact cause of this incident."						
I002363-001 05/13/94	Fish Striped mullet Florida gar	N/R 1450 50	Citrus Registered use	FL	water	0.76 ppb
Source is the Pesticide Contamination in Ten Mile Creek issued by FDEF. Ten Mile Creek is a major tributary of the North Fork of the St. Lucie River. Anonymous complaint. Analysis showed endosulfan analogues, ethion and azinphos methyl. Levels violated water quality standards.						
I004633-001 9/21/87	fish	N/R	Aerial	GA	N/R	N/R
This incident occurred in a pond in Lenox, GA. A fish kill occurred in a fish pond bordered by areas that were aerially treated with Guthion 2L.						
I002335-001 05/20/96	fish	N/R	Nursery Misuses (accidental)	GA	water	26 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
This incident occurred in a small creek near Whites Nursery, Cairo, GA. Reported by Bayer Co. as a 6(a)(2) incident, dated July 14, 1995, with Guthion 50WP in Grady Co., GA. A holding pond that was to contain rain and irrigation water failed to contain runoff after rainfall that occurred 30 hours after guthion application. GDNR performed water analyses.						
I001849-010, I001863-001, & I001951-001 08/10/94	fish	20 killed reported by owner 4 killed reported by inspector	Cane Misuse (accidental)	LA	N/R	N/R
See PART II Below						
I001849-011, I001863-003, & I001951-001 09/06/94	Bowfin Gar Crappie	1000 N/R Unknown	Cane Registered Use	LA	N/R	N/R
See PART II Below						
I000203-001 07/10/92	Bass Bream Buffalo Blue Catfish Gar White Perch	2000 14000 200 200 3000 600	Cane Registered Use Aerial	LA	water	sample # 11-07-21-92A 5.8 ppb sample # 11-07-21-92B 1.8 ppb sample # 034920721010 17.4 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
Incident occurred in Avoyelles Parish, LA. Complaint from Dept. of Wildlife and Fisheries to Pesticide Enforcement. Dead fish were first spotted 7/18/92 and 7/19/92. Water and sediment samples were taken Jason Duratt (DEQ) and Pete Gullett (Pesticide Enforcement) observed dead fish and collected samples. Fish ranged in size from fingerlings to approximately 10 pounds. Area farmer's used Guthion at 3 pints per acre that was applied aerially. According to the National Wildlife Service Climatological data sheet rain occurred on the dates of July 15, 16, 17, 18 (twice), 19, and 20, 1992. According to the memorandum of July 27, 1992 from Jason Dewitt, EQS-KCRO to Jon Kern, Ambient Coordinator that "the cause of this fish kill was pesticide runoff a brief summary of the reasons for this conclusion is below: 1. A wide spectrum of species was effected including gar. 2) Recent rains and pesticide application during this period. 3. Rain runoff into the bayou drains directly through agricultural fields. 4. Pectoral fins of fish were thrust forward. 5. The pesticide used (Azinphos methyl) is toxic to fish."						
I000203-002 08/09/92	Spotted Gar Shad Southern Flounder Striped Mullet Mosquitofish Croaker	Total of 1000	Agricultural Area Registered Use Aerial	LA	water fish tissue (muscle and liver)	0.15 , 0.22 & 11 ng/ml >30 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	Species	Effect/#	Crop	St	Residue Analysis	
					Item	Conc. (ppb)

Comments

The incident occurred in Jacks Coulee (Bayou Jack) in New Iberia, LA. Three water samples and one fish sample were taken. Analyses were performed by Louisiana State University Veterinary School. The kill was estimated at 1000. The kill contained both juvenile and adult fish of various species (see above). Statement of local farmer indicated that 269 acres of cane was aerially treated with azinphos methyl on Thursday, August 6. There is a catch canal that is pumped into Jacks Coulee, and also that some runoff goes directly into Jacks Coulee. The area that was treated received 1 1/4 inch of rain on Saturday afternoon and more showers Sunday afternoon. On Sunday morning (8:00 am) the catch canal pump was stopped. All three water samples showed azinphos methyl. In addition to the fish kill shrimp and juvenile blue crabs were observed swimming near the surface.

Report indicated that the dissolved oxygen was above the tolerance of the species observed. The fish behavior, erratic swimming, darting across the surface, swimming lethargy, and disoriented manor, suggests a toxic substance, very similar to fish which were observed here in 1991 which was attributed to the pesticide azinphos methyl. Fish were in the process of dying at the time of investigation.

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
I000203-003 08/04/92	White Crappie Spotted gar Atlantic croaker Bluegill Warmouth Striped mullet Gambusia Freshwater drum Gulf menhaden Largemouth bass Southern flounder Carp American eel Yellow bullhead White Bass Blue Crab	5000 to 6000 dead	Agricultural Area Registered Use Aerial	LA	water	46 to 70 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	Species	Effect/#	Crop	St	Residue Analysis	
					Item	Conc. (ppb)

Comments

This incident occurred on August 4, 1992, at Bayou Petite Anse and Hayes Coulee in Iberia Parish, LA. The LDAF and DEQ investigated the incident on August 5, 1992 at Bayou Petite Anse and Hayes Coulee. Dead fish were observed in Hayes Coulee and in drainage ditches from sugarcane fields that drain into the two bodies of water. Water was brown in color with a light scum on top.

Witnesses said that they had seen a helicopter treating sugarcane fields on August 1st and 2nd; but there were a few dead fish observed on July 30. No count was available for this day.

Three water and one sediment samples were taken (2 water and 1 sediment in Hayes Coulee and 1 water in Bayou Petite). Primarily sugarcane and soybeans are planted in the area. According to Penn Tex Helicopter records Guthion was applied to 897.4 acres on August 2, 1992 at a rate of 3 pt. acre. On August 2 &3 Sniper was applied to 140 acres of sugarcane at 3 pt. per acre. On June 29 and 30 Guthion was applied to 686.3 acres at 3 pts. per acres.

Azinphos methyl was found in two of the water samples 46 and 70 ppb.

Excerpted from the LDAF complaint form Inspector's summary by Johnny Timmons and Merrill Dupre; "In conclusion, since a helicopter does not have to get out of the sugarcane field during treatment, we do not suspect any over-spray. Also MR. Ted Brousard reported 3/4 of an inch of rainfall on August 3, 1992; possibly their was runoff from cane fields that were treated on August 2, 1992." Furthermore the conclusions of the investigation report says "The results of the chemical evaluation of the water samples suggests that the presence of the insecticide azinphos methyl was the cause of this fish kill event

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
I000146-001 07/18/92	Bream Black Bass Alligator gar Bluegill Redear sunfish Catfish Buffalo White crappie White perch	1050 1500 2250 N/R N/R 150 150 N/R 450	Canefield Registered use Aerial	LA	water	1.8 and 5.8 ppb
This fish kill incident occurred at Bayou Rouge, Evergreen LA (Avoyelles County). According to the Investigation Report by LSU/LDAF Fish Investigation Team two water samples contained 5.8 ppb and 1.8 ppb of azinphos methyl. Under the conclusions of this report; "The results of the chemical evaluation of the water samples suggests that the presence of the insecticide azinphos methyl was the cause of this fish kill event."						

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
I000146-002 8/5/92	Striped mullet Atlantic croaker Gizzard shad Assorted sunfish Blue crab Mosquito fish Spotted Gar Bowfin Minnow Shad Bluegill Warmouth White Bass Freshwater drum Gulf menhaden Largemouth bass White crappie Southern flounder Carp American Eel Yellow bullhead Blue Catfish	N/R	Canefield, Soybeans Undetermined Aerial	LA	water	46 and 70 ppb
This fish kill incident occurred at Avery Island, LA (Iberia County). According to the Investigation Report by LSU/LADAF Fish Investigation Team two water samples contained 46 ppb and 70 ppb of azinphos methyl. Under the conclusions of this report; "The results of the chemical evaluation of the water samples suggests that the presence of the insecticide azinphos methyl was the cause of this fish kill event."						

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
I000146-003 08/08/92	Striped mullet Southern flounder Spotted Gar Shad Atlantic croaker Mosquito fish	N/R	Canefield Undetermined Aerial	LA	water fish tissue (muscle and liver)	0.15 , 0.22 & 11 ng/ml >30 ppb
This fish kill incident occurred at Bayou Jack, LA (Iberia County).According to the Investigation Report by LSU/LADAF Fish Investigation Team muscle and liver tissue analyses >30 ppb of azinphos methyl was detected, and the analyses of three water samples indicated azinphos methyl at 11 ng/ml, 0.22 ng/ml, and 0.15 ng/ml. Note: This incident has been logged in twice to the Ecological Incident Information System (EIIS) see Incident #: I000203-002.						
I000114-001 7/21/91	Fish	10000	Canefield Undetermined Aerial	LA	N/A*	N/A*
The following memoranda were listed under this incident number (I000114-001). 1) August 14, 1992. Note to Doug Campt, Susan Wayland, Bill Jordan and OPP Division Directors. From Keola P. Murray. RE: Azinphos methyl fish kills in southern Louisiana. Attach were the following: **a)** August 13, 1992 memoranda from Region VI notifying headquarters of a fish kills around, July 21, 1991 in Avoyelles Parish of about 10,000 to 20,000 fish, on August 5, 1992 in Iberia Parish of about 4,000 to 5,000 fish, and a third fish kill on August 9, 1992. Based on laboratory analysis of water samples the first two fish kills were definitely associated with azinphos methyl, and the third also appears to be associated with azinphos methyl. **b)** August 11, 1992 news article following a news release from Commissioner Odom of the LDAF. **c)** August 13, 1992 Section 27 Referral letter from Region VI to the Director of Pesticides and Environmental Programs, LDAF, Requesting investigations of the recent fish kills and report investigative findings. *NOTE SEE ALSO INCIDENT NO.'s: I000203-001, 002, 003.						
I000109 July and August 1991	fish kill	N/A	N/A	LA	N/A	N/A

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**

Comments

Letter from Miles Corp. to Dennis Edwards RD/OPP/USEPA. Subject: Guthion 2L, EPA Reg. No. 3125-102 Use on Sugarcane. Letter discusses numerous fish kills that occurred in the sugarcane growing region of Louisiana during July and August of 1992. In the letter according to Miles Corp. that at the time no single cause for the fish kills had been identified, but azinphos methyl had been mentioned as a causative agent. The LDAF established a panel to evaluate the findings from these Incidents. According to this correspondence Miles Corp. cooperated fully with the LDAF. Miles provided the three following documents with this letter, Miles also indicated that it was there under standing that these documents have already been provided to EPA:
1) "Report on July-August, 1991 Fish Kills in South Louisiana" prepared by the LDAF-appointed panel and submitted to Mr. Bob Odum Commissioner LDAF
2) "1991 Fish Kill Report and 1992 Prevention Initiative" presented to the Louisiana Advisory Commission on Pesticide, November 1991 by LDAF
3) "Louisiana Department of Environmental Quality Office of Water Resources Fish Kill Summary 1991."

Material for informational purposes was also enclosed: <u>Sugarcane Insecticide and Environmental Concerns</u> by Dr. W. Henry Long (Incident Id No.: I000109-001) and an article from the <u>Sugar Bulletin</u> entitled "1991 Crop Yield and 1992 Outlook" by Dr. Charley Richard (Incident Id No.: I000109-001).

This letter summarizes the measures of the LDAF that were taken due to the events of 1991:
<u>LABEL MODIFICATIONS for GUTHION 2L</u>
- Total number of applications was reduced from 5 to 3.
- 21 day intervals are required between applications.
- Guthion 2L cannot be applied within 75 feet of lakes; reservoirs; rivers; permanent streams, marshes, or ponds; canals; estuaries and commercial fish farm ponds.
- Guthion 2L cannot be applied if the soil is saturated with water.
- Guthion 2L cannot be applied under conditions that favor runoff.

<u>LABEL MODIFICATIONS added to the SUGARCANE PORTION of the LABEL</u>
- All application equipment must be properly maintained and calibrated using appropriate carriers.
- Do not make applications during temperature inversion. A temperature inversion is a stable atmospheric condition characterized by an increase is air temperature with increased height above ground until at some heights a "ceiling" or barrier of colder air is met.
- Make applications when the wind velocity favors on target product deposition (approximately 3 to 10 mph). In Louisiana do not apply when wind velocity exceeds 10 mph.

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
I000109-002 6/27/91	Striped mullet Freshwater drum Bluegill Yellow bass Warmouth Hog choker Mosquito fish Crappie Spotted Gar Shad Silverside	5000 estimated	Sugarcane/ Aerial	LA	water	4.2 ppb
This incident occurred at Jacks Coulee (Bayou) in Iberia Parish, LA. Dead fish were reported to have their pectoral fins pointed forward and the fish that were still alive showed disoriented swimming at the surface in obvious distress. Residents reported surrounding sugarcane fields sprayed with pesticides prior to kill. Crop duster confirmed spraying with azinphos methyl prior to kill. 3 stream miles affected. According to the Report no July-August, 1991 Fish Kills in South Louisiana submitted to Mr. Bob Odum, LDAF table 1 this incident was pesticide related. Furthermore in LDEQ Memorandum of July 30, 1991 from W. J. Tucker, to B. Brousseau, regarding Fish Kill on Jacks Coulee indicated: - "The suspected cause of the fish kill is the organophosphate pesticide azinphos methyl. This pesticide is suspected for the following reasons. In interviews with several area residents they indicated that crop dusters had been observed spraying the sugarcane fields around Jacks Coulee over the past several days prior to the fish kill. In addition they said it had been raining almost every afternoon that week. The behavior of the fish which were observed was typical of a reaction to organophosphate poisoning." According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner. "LDAF could not make a determination as to the cause of the fish kill."						

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
I000109-003 7/2/91	Spotted gar Striped mullet Gizzard Shad Warmouth Various sunfish White crappie Carp turtles snakes duck	5000 estimated 3 4 1	Sugarcane Aerial	LA	water	428 ppb 21 ppb in ditch draining aerial applicator's site

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	Species	Effect/#	Crop	St	Residue Analysis	
					Item	Conc. (ppb)

Comments

This incident occurred in Vermilion Parish, Seventh Ward drainage canal (NOAEL Canal). Fish exhibited erratic behavior, appeared to be trying to jump out of the water. Crop duster sprayed azinphos methyl 2 days prior to kill. Ditch draining airfield area filled with dead invertebrates, no living animals observed, 4 miles affected. Furthermore in LDEQ Memorandum of July 23, 1991 from J.P. Jackson, to B. Brousseau, regarding Fish Kill in the Seventh Ward Drainage Canal noted the following:

- nearly all dead and dying fish present had their pectoral fins in an extreme forward position.
- field parameters (temperature, D.O., conductivity and pH) were normal confirming the LDEQ representative's suspicion of chemical poisoning. The LDEQ representative (J.P. Jackson) walked 1/4 miles stretch observed many dead fish. However, the one genus that was not observed was catfish. "The lack of catfish mortalities and the presence of dead garfish would indicate that the fish kill was not cause by anoxia."
- The LDEQ representative proceeded to the closest flying strip, Sagera's Flying Service. "The end of Sagera's flying strip butts up against the canal. Upon arrival I observed a <u>water hose in a chemical mixing tank that was overflowing</u>."
- The applicator indicated that Guthion was used 2 days before (June 30, 1991) to spray sugarcane but had not been applied since.
- A discharge sample was taken at the end of the runway by the LDEQ representative. "the drainage from the chemical mixing area discharges into the drainage canal at this point."
- The LDEQ representative inspected the drainage ditch. "At every section of this ditch there were <u>dead invertebrates</u> such as snails, slugs, worms, and crawfish. In fact no living organisms were observed over the length of the ditch. The color of the water also had a very slight pinkish tint and had a slight chemical odor. The whole ditch appeared sterile of both plant and animal life.
- Samples: The canal at Parkish Rd. - Guthion at 428 ppb; Grab sample taken at Sagera's Flying Service property - Guthion 21.9 ppb. There was no detection in fish.

According to the <u>1991 Fish Kill Report 1992 Prevention Initiatives</u>, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner. "Because of the extensiveness of the fish kill and high concentrations of chemical found in the drainage ditch and canal waters, it must be concluded that <u>a spill of Guthion caused from the airstrip caused the kill</u>. LDAF did not receive a report of the spill prior to DEQ's investigation."

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
I000109-004 7/6/91	Various sunfish Striped mullet Largemouth bass Yellow bass Crappie Freshwater drum Channel catfish Spotted gar Ladyfish	133,837 estimated	sugarcane	LA	water	1.42 ppb
This incident occurred in Lafourche Parish at Bayou Lafourche. It was observed that some species of fish swam erratically,other swam in circles, still other appeared moribund, no piping was observed, pectoral fins oriented forward. Residents observed pesticide spraying over several days prior to kill, one observer said spraying occurred directly over bayou. 10.4 miles were affected. The Report on July-August, 1991 Fish Kills in South Louisiana submitted to Bob Odum, Commissioner LDAF, the panel indicated that the incident in Bayou Lafourche was chemical related. According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner. - "DEQ identified the alleged origin of the kill as coming from the McLeod Pumping Station since no dead fish were seen north of the station and the natural flow of the bayou is in a southerly direction. McLeod Pumping Station drains a large area of sugarcane fields that lie adjacent to the Bayou" - "DEQ inspectors concluded that the fish kill was pesticide caused since the residents had seen aerial applicators spray the adjacent fields prior to the kill. Although a DEQ sample that was taken on July 6 was negative, DEQ concluded that fish behavior in water and when taken out exhibited a toxic reaction to pesticides." - "LDAF investigation confirmed that a large fish kill had occurred; however, live fish were also observed in the area of the kill site. A water sample taken at the McLeod Pumping Station produced positive result of azinphos methyl of 1.36 ppb. LDAF concluded that the fish kill was due to the presence of azinphos methyl."						
I000109-005 7/6/91	fish	26,400	Sugarcane Aerial	LA	water	ND

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	Species	Effect/#	Crop	St	Residue Analysis	
					Item	Conc. (ppb)
Comments						
This incident occurred in St. James Parish, LA, in Blind River. According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991: - 26,400 dead fish were reported. Residents reported recent spraying of sugarcane fields. 2.5 miles affected. According to Report on July-August, 1991 Fish Kills in South Louisiana submitted to Bob Odum, Commissioner LDAF, the panel indicated that the incident in Blind River was due to low dissolve oxygen (D.O.)(see Table 1) According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner. - Under Blind River 1 "Dissolved oxygen readings taken by DEQ on July 6 demonstrated a range of 0.5 - 4.0. Because of the response time, LDAF could not make a determination as to the cause of this fish kill."						
I000109-006 7/8/91	Striped mullet	100-200 observed	Sugarcane	LA	water	5.1 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
This incident occurred in Vermilion Parish, LA at Bayou Boston - Boston Canal. According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991: - The fish that were observed were swimming erratically. Complainant reported sugarcane fields in vicinity had recently been sprayed. Approximately 3,000 dead fish were reported by complainant 5 miles affected. In LDEQ Memorandum of July 24, 1991 from N.A. Herbert, to B. Brousseau, regarding Fish Kill Bayou Boston - Boston Canal, Vermilion Parish noted the following: - "The cause of the fish kill could not be determined, however low oxygen content can be probably ruled out as evidenced by the measurements taken during the investigation. Because the complainant had observed the aerial application of pesticides to sugarcane field in the area, it is suspected that organophosphate poisoning was the cause of the fish kill." - "Addendum: Analysis results of a water samples collected by LDAF were positive for azinphos methyl at 5.1 ppb." According to the Report on July-August, 1991 Fish Kills in South Louisiana submitted to Bob Odum, Commissioner LDAF, the panel indicated that the incident in Bayou Boston - Boston Canal no decision has been made as to the cause of the incident. According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner. -"Fish could not be analyzed due to decomposition, but water results were positive for azinphos methyl at 5.1 ppb. Record inspections of aerial applicators who serviced sugarcane fields which were near the fish kill site did not reveal any abnormalities. There were no witnesses to any apparent pesticide use violations. **LDAF concludes that azinphos methyl caused this kill**".						
I000109-007 7/8/91	Gulf menhaden Striped mullet Blue catfish Various sunfish Spotted gar Shad	500 observed, no total estimate	Sugarcane	LA	water	3.23

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	Species	Effect/#	Crop	St	Residue Analysis	
					Item	Conc. (ppb)
Comments						
This incident occurred at Port of Iberia, Iberia Southern Drainage Canal, Iberia Parish, LA. According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991: - Fish were acting erratically. 6 miles affected. In the LDEQ Memorandum of July 25, 1991 from W. J. Tucker, to B. Brousseau, regarding Fish Kill Port of Iberia, Iberia Southern Drainage Canal, Iberia Parish noted the following: - "The primary cause of this fish kill appears to be the organophosphate pesticide azinphos methyl. Two water samples were collected by the La. Dept. of Agriculture were positive for azinphos methyl. Samples collected on 7/9/91 had a concentration of azinphos methyl of 3.23 ppb. Because of the short half-life of this compound it can be assumed that concentrations at the time of the fish kill were significantly higher than those reported." According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner. - "LDAF concluded that this fish kill resulted from low dissolved oxygen and the presence of azinphos methyl."						
I000109-008 7/8/91	Striped mullet Spotted gar Carp White crappie Bowfin Warmouth Various sunfish Largemouth bass	3000 estimated	Sugarcane Aerial	LA	water	1.4 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	Species	Effect/#	Crop	St	Residue Analysis	
					Item	Conc. (ppb)

Comments

This incident occurred in Bayou Patout, Iberia Parish, LA.

According to the <u>LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991</u>:
- Fish were badly decomposed. It was not possible to estimate the total number of dead fish. Local fisherman observed spraying of cane fields and reported that spraying did not stop when plane flew over canal.

In the LDEQ Memorandum of July 26, 1991 from J.P. Jackson, to B. Brousseau, regarding Fish Kill in Bayou Patout, Iberia Parish noted the following: Fish actually started dying on July 6,1991. The LDEQ representative arrived at the scene during a heavy thunderstorm. According to the LDEQ representative upon reaching Bayou Patout dead fish were observed, these were very decomposed, and there was a strong current due to the thunderstorm. Found sugarcane fields along both sides of the bayou. According to the LDEQ representative; "At this time there was an enormous discharge of storm water from these sugarcane fields into Bayou Patout." Approximately 3 miles of stream were affected. "The cause of this fish kill is unknown, because of the species that were killed, garfish and bowfin, and the eyewitness account of the crop dusters spraying the field, organophosphate pesticides are suspected."

According to the <u>1991 Fish Kill Report 1992 Prevention Initiatives</u>, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner.
- LDAF inspectors surveys area farmers and applicators for the frequency and volume of pesticides applied to area sugarcane fields and found that such met label requirements. Local climatological data indicated: 3.5 inches of rain on July 5; 1.54 inches in July 16.
- "Without any witnesses and since records inspections of area applicators did not demonstrate any irregularities, no pesticide use violations could be identified and the LDAF did not make a determination as to the cause of the fish kill."

Incident No./ Date	Species	Effect/#	Crop	St	Item	Conc. (ppb)
I000109-009 7/8/91	Gar Buffalo Drum many other species	2000 estimated 65 observed	Sugarcane Aerial	LA		no data

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	Species	Effect/#	Crop	St	Residue Analysis	
					Item	Conc. (ppb)

Comments

This incident occurred at White Castle Canal, Logging Canal to Bay Natchez, and Rocky Canal, Iberville Parish, LA.

According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991:
- White Castle Canal an estimated 2000 dead fish were reported. These were badly decomposed.
- Logging Canal to Bay Natchez 65 dead fish were observed. These were badly decomposed.
- Rocky Canal, Iberville Parish No fish were observed. The kill seen by resident 2 weeks prior to reporting.
- Residents reported pesticides applied to sugarcane fields prior to fish kill.

In the LDEQ Memorandum of July 26, 1991 from C. Piehler, to B. Brousseau, regarding Basin Segment 1202 Recent Fish Kills White Castle Canal, Rocky Canal, Bay Natchez:
- "The presence of rough species (i.e. garfish) would dissuade one of the theory of a low dissolved oxygen related kill. Area residents report that fish kills have been noticed after pesticide application on adjacent sugarcane fields. Due to the consistent inclement weather (i.e. prolonged periods of heavy rainfall), the presence of pesticides in rain water runoff at biotoxic levels appears very possible."

According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner.
- "It should be note, also, that LDAF dissolved oxygen readings taken on July 8 illustrated a reading of 1.2-2.5. Therefore, LDAF concluded that this fish kill was a result of low dissolved oxygen."

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
I000109-010 7/11/91	Striped mullet Bluegill Yellow bass Warmouth Freshwater drum Mosquito fish Shad Crappie Spotted Gar Southern flounder Carp Sunfish Red Eared turtle Alligator (4ft' Long)	5500 estimated 2 1	Sugarcane Aerial	LA	water	18.6 ppb 2.5 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	Species	Effect/#	Crop	St	Residue Analysis	
					Item	Conc. (ppb)

Comments

This incident occurred in Bayou Petite Anse, Poufette Canal, Iberia Parish, LA.

According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991:
- Behavior/Appearance: Fish had pectoral fins pointed forward. Both Large and small fish were observed. No piping at the surface.
- Other Information: Aerial application to sugarcane fields adjacent to both banks of bayou one day earlier. 2 Red Eared turtles and 1 alligator found. 5 miles affected.

In the LDEQ Memorandum of July 25, 1991 from W. J. Tucker, to B. Brousseau, regarding Fish Kill in Bayou Petite Anse and Poufette Canal:
- "Dead fish were observed over a total of approximately 13 miles of stream."
- "The probable cause of this fish kill is poisoning due to runoff from sugarcane fields adjacent to Bayou Petite Anse and Poufette Canal" The rational being that the complainant observed that the fields adjacent the bayou were treated prior to a rainstorm "puts a toxic agent in the immediate vicinity of the fish kill and the fact that it rained would provide a mode for the pesticide to get into the water. Many of the fish observed had their pectoral fins extended anteriorly, a condition typical of organophosphate poisoning. The field water quality parameters indicated that stream conditions were within suitable limits. Fish were not seen piping at the surface, a behavior which is common in fish kills cause by low dissolved oxygen. In addition fish such as garfish and mosquito fish, which were observed in this fish kill are rarely killed in D.O. fish kills. Both large and small (juvenile) fish were observed killed, D.O. kills generally do not affect small fishes. Fish species, such as shad and gulf menhaden, that are numerous in D.O. fish kills were rare or absent from this incident."

According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner.
- "LDAF inspectors could find no witness to pesticide use violations and records inspections failed to identify any irregularities. LDAF concluded that fish kill resulted from the presence of azinphos methyl."

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
I000109-011 7/12/91	Gar Crappie Freshwater drum Largemouth bass Mullet Various sunfish	3000 estimated	Sugarcane Aerial	LA		no detect
This incident occurred in Wilberta Canal, Iberville Parish, LA. According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991: - Behavior/Appearance: Fish had pectoral fins pointed forward. - Other Information: Complainant reported aerial spraying of pesticides on adjacent sugarcane fields. 4 miles affected.						
I000109-012 7/13/91	Striped mullet Spotted Gar Bowfin Freshwater drum Common Carp Bluegill Warmouth White crappie Black crappie Blue catfish Largemouth bass	2,000+ estimated	Sugarcane Aerial	LA	water	4.81 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
This incident occurred in Tete Bayou, Iberia Parish, LA. According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991: - Behavior/Appearance: Fish had pectoral fins pointed forward, body tremors - Other information: Plane sprayed previous day. 5 miles affected. In the LDEQ Memorandum of July 26, 1991 from W. J. Tucker to B. Brousseau, regarding Fish Kill in Tete Bayou, Iberia Parish: - "The cause of this fish kill appears to be the organophosphate pesticide azinphos methyl. A water samples collected by La. Dept. of Agriculture personnel on 7/15/91 had an azinphos methyl concentration of 4.81 ppb. Due to the short half life of this compound in water the concentration at the time of the fish kill would have been significantly higher. The sample was collected two days after the fish kill was initially discovered." According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner. - "However, LDAF does attribute this kill to the presence of azinphos methyl."						
I000109-013 7/17/91	Striped mullet Sunfish Spotted Gar Other species	500 observed	Sugarcane Aerial	LA	water	7.8 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
This incident occurred in Bayou Tigre, Vermilion Parish, LA According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991: - Behavior/Appearance: erratic swimming, all sizes affected. - Other Information: Sugarcane fields in vicinity, 5 miles affected. In the LDEQ Memorandum of July 26, 1991 from N.A. Hebert, to B. Brousseau, regarding Fish Kill Bayou Tigre, Erath LA, Vermilion Parish: - "The cause of this fish kill is unknown, however due to the numerous spotted garfish which were observed and the presence of sufficient dissolved oxygen concentrations in the stream, low dissolved oxygen was apparently not the cause of this kill. Because of the proximity of sugarcane fields to this location and the presence of dead garfish, organophosphate poisoning is a possibility." - Addendum to this memorandum: "7/19/91 sample was positive for azinphos methyl at 7.8 ppb." According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner. - "However, LDAF could identify no pesticide use violations and concluded that the presence of azinphos methyl caused this fish kill."						
I000109-014 7/24/97	none observed	unknown	Sugarcane	LA	no data	no data
This incident occurred in Jeanerette Canal, Lake Fausse Pointe, Iberia Parish, LA. According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991: Other Information: Complainant said fish kill occurred around 7/13/91 after sugarcane was sprayed. Miles affected unknown.						

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	Species	Effect/#	Crop	St	Residue Analysis	
					Item	Conc. (ppb)
Comments						
I000109-015 7/29/91	Spotted Gar Gizzard Shad Blue Catfish Mosquitofish Largemouth bass Bluegill Warmouth Crappie Sunfish Mullet Freshwater drum	15,000 estimated	Sugarcane	LA	water	2.74 ppb 8.96 ppb 15.72 ppb

This incident occurred at Blind River, St James Parish, LA (Note: this incident is also known as Blind River II).

According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991:
- Behavior/Appearance: All sizes affected. Numerous predators feeding on dead fish (i.e. birds, snakes, turtles, alligators)
- Other Information: Local fisherman reported that spraying occurred the day prior to the fish kill and that there was a heavy rain that afternoon. 3 miles affected. This was the **second fish kill** in this water body. The first fish kill occurred on 7/4/91.

In the LDEQ Memorandum of July 30, 1991 from David Oge', Southeast Regional Coordinator, Office of Water Resources, Southeast Regional Office to B. Brousseau Surveillance Program Manager, regarding Blind river Fish Kill Investigation:
- "Local residents observed aerial spraying in the sugarcane fields in the Grand Point area Friday morning. There was a very heavy rain in this area Friday afternoon. The river turned from a clear color to a very muddy condition overnight and the fish started dying.

According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner.
- "LDAF concluded that this fish kill resulted from low dissolved oxygen and the presence of Azinphos methyl."

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
I000109-016 8/6/91	Mosquito fish Spotted Gar Sunfish Juvenile sunfish Largemouth bass Pirate perch Golden shiners Catfish	200,000 estimated	Sugarcane Aerial	LA	water	22.1 ppb
This incident occurred in Himalaya Canal (a/k/a Martel Canal) and Bayou Louis to Lake Verret, Assumption Parish, LA. According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991: Behavior/Appearance: All sizes affected, body tremors, fins pointed forward. Other Information: Local residents observed aerial application in area prior to kill. 3.5 miles affected. According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner. - Canal drains nearby sugarcane fields, cypress swamps, and a sugar refinery discharge. - "A review of aerial applicator records revealed that Azinphos methyl had been applied to area sugarcane fields, but no irregularities were identified. LDAF concluded that this fish kill was the result of low dissolved oxygen and the presence of azinphos methyl."						
I000109-017 8/15/91	Bowfin Gar Bass Sunfish Catfish	500+ estimate	Sugarcane Aerial	LA	water	1.19 ppb 2.73 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
This incident occurred in Williams Canal (a/k/a Bayou Brusly), Assumption Parish, LA. According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991: Behavior/Appearance: Dead 2-3 days. Other Information: 3 miles of stream affected, 3 large drainage ditches from sugarcane field empty into canal. According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner. - Water samples indicated azinphos methyl at 2.5 and 4.1 ppb - "LDAF concluded that this fish kill was the result of low dissolved oxygen and the presence of azinphos methyl."						
I000109-019 8/15/91	Gar Bass Bream Crappie Mullet	5,000+ estimate	Sugarcane	LA	water	6.3 ppb
This incident occurred in Bayou Sale' - Quintina Area (Yellow Bayou and Thorguson Canal) St. Mary Parish, LA According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991: Behavior/Appearance: Dead 1-5 days, pectoral fins pointed forward. Other Information: 3 miles affected, Large pump station drains sugarcane fields in the area. According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner. - "Records of aerial applicators who serviced area fields revealed that a two hundred acre field which is north of the kill site was sprayed with azinphos methyl on August 12. Climatological indicate 0.19 inches of rainfall fell on August 12 and 1.1 inches on August 14. LDAF attributes this fish kill to the presence of azinphos methyl."						

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
I000109-019 8/16/97	Bass Bowfin Gar Bream White crappie Drum Mullet Bullhead catfish	2,000+ estimate	Sugarcane Aerial	LA	water	16.55 ppb
This incident occurred in a drainage canal (Loureauville Canal) into Lake Fausse Pointe, Iberia Parish, LA. According to the LDEQ Office of Water Resources, Summary of 1991 Fish Kills, South Louisiana Area, September 1991: Behavior/Appearance: All sized affected most dead 24 hours; some in the process of dying with their bodies vibrating, and some with pectoral fins pointed forward. Other Information: 2 miles affected. Canal drains sugarcane fields Planes spraying the area at time of investigation. According to the 1991 Fish Kill Report 1992 Prevention Initiatives, presented to the Louisiana Advisory Commission on Pesticide, November 1991 by the LDAF, Bob Odum Commissioner. - "Dissolved oxygen readings taken by DEQ were in a range of 3.9-4.6. Water samples demonstrated positive signs of Azinphos methyl at 16.8, 40.00 ppb. Climatological records reported rain fall of 0.65 inches on August 15. LDAF concluded that this fish kill is clearly a result of the presence of Azinphos methyl."						
I000247-002 8/18/92	Bass Bream Gar Crappie Catfish some crustaceans (LDEQ)	not reported	Sugarcane Aerial	LA	water	N/R

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
This incident occurred in Company Canal, near Gheens, LA, Lafourche. According to the <u>Fish Kill Investigation on Company Canal #92-62 Gheens, LA - HWY. 654 Lafourche Parish, LA</u> prepared by LDAF: - The fish kill occurred in the week of the 10th due to the state of decay of the fish. - Land on both sides of the canal is used for sugarcane. - Approximately 2000 acre of sugarcane was aerially treated with Guthion. - Precipitation occurred after application. (8/18/92 2+ inches of rain) - "After interviewing the aerial applicators and witnesses to the fish kill it appears that no apparent misuse of the chemical azinphos methyl was found."						
I000247-003 8/17/92	Gar Bowfin Warmouth sunfish Largemouth bass	103 17 3 1	Sugarcane Aerial	LA	water	65.28 ppb 2.6 ppb 0.76 ppb (Asana)
This incident occurred on Brazan Canal (#92-61), Vacherie, LA, St. James Parish. Conclusion of the LDEQ was that "the fish were killed by runoff from the cane fields after crop dusting with azinphos methyl"						
I000247-004 8/15/92	bass bream catfish	numbers not reported	Sugarcane Aerial	LA	water foliage	degradation product of Guthion
This incident occurred on Theriot Canal (#92-60), Northwest of Raceland, LA in Lafourche Parish. According to the LDAF report <u>Fish Kill Investigation on Theriot Canal (#92-60), Northwest of Raceland, LA in Lafourche Parish</u> - fish kill was approximately 2 miles long. - sugarcane grown on both sides						
I000454 1992	see below	see below	see below	LA	see below	see below

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
The 1992 Fish Kill Investigation Presented to The Louisiana Advisory Commission on Pesticide, LDAF, Bob Odom, Commissioner found that the following fish kills were caused by the pesticide azinphos methyl. 1) **I000454-007** Bayou Rouge, #92-37. 7/21/97 2) **I000454-011** Petite Anse, Hayse Coulee, #92-47. 8/4/92 3) **I000454-013** Bayou Jack, #92-53. 8/9/92 4) **I000454-015** Theriot Canal, #92-60. 8/16/92 5) **I000454-016** Brazen Canal, #92-61. 8/17/92 6) **I000454-017** Company Canal, #92-63. 8/18/92 7) **I000454-014** Delahoussaye Canal, #92-55. 8/10/92 (Guthion and Low D.O.)						
I000709-001 8/2/93	Perch	40	Sugarcane	LA	water	7 ppb
6(a)(2) submission by Miles Corp. on 10/8/93. This incident occurred near Teriot, LA. Incident occurred in a pond near a 4 acre sugarcane field. The field was treated on 7/30/93.						
I000979	fish	see below	see below	LA	see below	see below
6(a)(2) submission from Miles Corp. of 4/21/94 1) **I000979-002** (8/19/93) Fish kill #93-48. Apparently occurred in Arkansas and the dead fish floated into LA. The 1993 Fish Kill Investigation Report presented to the LA advisory commission on pesticides listed this incident at Bayou Bartholomew. Water analyses of the bayou showed azinphos methyl at 4.96 and 0.55 ppb. The conclusions in the report indicated that azinphos methyl was the cause of the fish kill. 2) **I000979-003** (9/93) Fish kill #93-56. Azinphos methyl was found in water at 1200 ppb and 52 ppb. According to The 1993 Fish Kill Investigation Report presented to the LA advisory commission on pesticides indicated that the incident was due to the washing of farm equipment.						
I001921-001 3/13/95	see below	see below	see below	LA	see below	see below

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
Correspondence from Miles Corp. to T. Moriarty of EPA/SRRD of March 13, 1995, regarding LDAF investigations, additional information. (Also refer to I001863 and I001849. Miles Corp. asserted that the analytical result of 7.6 ppb in Lalonde pond (Fish Kill #94-68) was to high. Miles asserts that azinphos methyl should be 0. to 0.24 ppb. This conclusion is based on calculated pond volume, land sloped away from the pond, and drift calculations. Miles concludes that "either (1) the analytical measurements are in error or (2) the claims of the pilot relative to the actual distance to the pond during application are in error."						
I004163-001 9/3/96	Shad Buffalo Gar	N/R	unknown	LA	fish	N/R
In a 6(a)(2) incident for Azinphos methyl dated 9/19/96 from Bayer Co. "The Louisiana State University /LDAF Fish Kill investigation team concluded that azinphos methyl was responsible for the fish kill."						
I004333-001, I004367-001	see below	see below	see below	LA	N/A	N/A
Louisiana Pesticide Monitoring Program analytical results from 1992 to 1996. 0.4 ppb of azinphos methyl was found at Bayou Tigre-HWY404 T11S R12E S1						
I004668-011 & I004875-011 8/7/96	Shad Buffalo Gar	600	sugarcane	LA		
This incident (96-75) occurred in Daves Bayou in Richland Parish According to the Louisiana 1996 Fish Kill report LSUSVM found azinphos methyl in water samples taken. Final Investigation Report LDAF Case 96-75; "Results of the chemical evaluation of the water sample suggest that the pesticide azinphos methyl was the cause of this fish kill"						
I005148	fish	see below	see below	see belo w	see below	see below

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	Species	Effect/#	Crop	St	Residue Analysis	
					Item	Conc. (ppb)
Comments						
This is a 6(a)(2) submission from Bayer Co. for Guthion. 1) **I005148-001** Fish kill in Lake Plains, NY in 1970. 2) **I005148-002** Fish kill in Lake Plains, NY in 1977. 3) **I005148-003** Fish kill in Kashmir, WA in 1993.						
I003659	fish & shellfish	see below	see below	VA	see below	see below
July 7, 1996 Washington Post article <u>Tomato Farms' Plastic Has Va. Watermen Seeing Red</u>, by Brad Wye. The article discusses the runoff that can occur from tomato plasticulture and it may affect the local aquaculture and fisheries on Virginia's eastern shore area. Pesticides that were mentioned in the article were esfenvalerate, azinphos methyl, and endosulfan.						
I004374-006 6/4/96	Sunfish Minnows	325	Orchard (apples)	MO		
This incident occurred in a pond in Jackson County MO. Missouri Dept. of Conservation report indicated the following: - Guthion suspected. - pectoral fins of dying fish were pointed forward.						
I003622-001 6/1/96	fish	N/R	Peaches	MO	water	not available
This incident occurred in Lee's Summit, MO, on 6/1/97. According to a 6(a)(2) submission by Bayer, Co. on 6/20/96. A peach orchard was treated with Guthion 50% WP per label instructions on 5/31/96. Within hours of application 2 inches of rain fell over a short time. June 1st and 2nd started to appear in a pond within 150 feet of the orchard. On June 4th it rained again and more dead fish were seen.						
I003439-001 5/4/96	fish	N/R	N/R Aerial Accidental	AK	water	16 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents						
Incident No./ Date	**Species**	**Effect/#**	**Crop**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
This incident occurred near Little Rock, AK. According to the 6(a)(2) report by Bayer C0., dated 5/16/96, a pond owned by Georgia Pacific Co. was aerially over sprayed "due to incorrect coordinates entered into the applicators directional system".						
I002338-001 6/5/95	fish	N/R	Cotton	TN	water	0.0004 ppm estimated by Bayer
This incident occurred in Oakfield TN. This is a 6(a)(2) notification from Bayer dated 7/14/95. According to the correspondence. A 50 acre cotton field, that drain into a 2 acre pond, was partially treated with Guthion 2L at a rate of 0.25 lb ai per acre. On June 6, 1995 2 inches of rain was reported in the area. On June 15, 1995 farmer reported dead fish in his pond. (days after the rain						
I001838-001 8/16/94	fish	N/R	Cotton	TN	water	guthion and bifenthrin
This is from a February 15, 1995 correspondence from FMC to EPA. The summary indicated that: "Dead fish were observed in a pond several hours after a torrential rain storm (over 4 inches) that moved soil from a recently treated cotton field of some 100 plus feet from the pond. The water samples from the pond contained both Guthion and bifenthrin."						
IOOO799	fish	see below	see below	NC	see below	see below
7/90, McDowell, Marion. Wilson's Pond and South Fork Hooper's Creek, Apple Orchard. 0.77 ppb azinphos methyl.						
I000721-001 7/2/93	fish	numerous	Cotton Aerial	MS	water	33 to 83 ppb

Table 2: Azinphos methyl (Guthion) Aquatic Incidents

Incident No./ Date	Species	Effect/#	Crop	St	Residue Analysis	
					Item	Conc. (ppb)
Comments						
6(a)(2) submission by Miles Corp. dated 10/13/93. According to the Mississippi Department of Environmental Quality Memorandum from H. Folmar (Laboratory Director) to Mr. Denman of 7/16/93: - "the kill was caused by a toxic material, and our lab results indicate that the material was the cotton insecticide Guthion."						
I001241	fish	>5000	N/R	MS	N/R	Guthion
Incident occurred at Denman's Lake, Tallahatchie County, MI on 7/4/93. The cause was agricultural runoff. Entire lake was affected (approx. 50 acres)						
I000592-001 & I000603-001 07/02/93	Catfish Perch	40+	Cotton Aerial	TX	water	0.09 to 19.4 ppb
This was reported in a 6(a)(2) submission from Miles Corp. on July 29, 1993. This incident occurred near Cemron, Milam County, TX. 6/12/92 - Cotton was aerially treated with Guthion 2L. It rained 3.5 inches within one hour after application. 6/13 and 14/92 - Dead fish observed in a pond adjacent to application site. 6/17/92 - Second application of Guthion 2L to this same field.						
I000200-037 07/01/92	Bluegill sunfish	450	not reported	WI	none	N/A
According to the WDATCP: "Approximately 450 fish died from an application of Guthion. A large rain occurred after the application and they could not control the runoff."						

<u>References:</u>
(CDFG) California Department of Fish and Game
(GDNR) Georgia Department of Natural Resources
(LDAF) Louisiana Department of Agriculture and Forestry
(LDEQ) Louisiana Department of Environmental Quality
(LSUSVM) LSU School of Veterinary Medicine

(MDEQ) Mississippi Department of Environmental Quality
(NCDA) North Carolina Department of Agriculture
(USEPA) United States Environmental Protection Agency
(WDATCP) Wisconsin Dept. of Agriculture, Trade & Consumer Protection

Abbreviations:
MDL - minimum detection limit
ND - not detected
N/R - not reported
N/A - not applicable

3) Review of the 1994 Aquatic Incidents on Sugar Cane in Louisiana

The two Incidents, **I001849-010 of 08/10/94 and I001849-011 of 9/06/94**, have been previously commented on. The following is excerpted from a memoranda dated March 6, 1995 the subject was the Review of Incident Data for Azinphos methyl. This memo was from Anthony F. Maciorowski, Chief, EEB to Evert K. Byington, Chief, SACS (DP Barcode: D213008):

> "EEB has received and reviewed the information (see attached) sent on or around February 21, 1995, to EPA by Miles, Inc., Agriculture Division, regarding Guthion (Azinphos methyl) fish Kill Incidents Reports and Louisiana Department of Agriculture and Forestry (LDAF) Investigations. The information is summarized below.
>
> The first document in the packet was the "1994 Fish Kill Investigation, Presented to the Louisiana Advisory Commission on Pesticides, Louisiana Department of Agriculture & Forestry, Bob Odom, Commissioner." This report contains an overview of the 105 fish kills reported to the LDAF. LDAF investigated the 105 fish kills and collected 102 samples from 49 fish kills. Of the 49 fish kills for which samples were collected, 11 were found to be caused by pesticides (see attached listing). Two of the 11 fish kills were attributed to Azinphos methyl fish kills and are discussed below.
>
> Of the 49 fish kills, 38 were found not to be caused by pesticides. Of the total 105 fish kills investigated, 51 were listed as having been caused by low dissolved oxygen (D.O.).
>
> The second set of documents discussed the investigation of a fish kill that occurred on or about August 10, 1994 and was attributed to azinphos methyl. According to the records, between August 6, 1994 and August 10, 1994, .33 dead fish were found and removed from a private pond in Opelousas, Louisiana. The pond was located south of an adjacent sugar cane field. LDAF and LDEQ investigated the kill and took several water samples. Along with some dead fish, they also found "phenoxy type" symptoms on weeds and trees around the pond and residence of the complainant. LDEQ, after taking D.O. readings from two locations found low D.O. at both locations and concluded that based on those readings "the fish died from low oxygen." Further investigation showed that the sugarcane had been treated with a combination of azinphos methyl and 2-4-D amine on August 5, 1994. According to information received from the Lafayette Weather Service on the date the application was made there was a northerly wind. Results of the water sample analysis indicated the presence of detectable levels of several parent pesticides including atrazine and azinphos methyl. Azinphos methyl was found at levels of 0.21 ppb and 7.6 ppb. Based on this information John McClelland (LDAF) concluded that the injury to both the pond and the trees resulted from the aerial application of 2-4-D Amine and Azinphos methyl to the adjacent sugar cane on August 5, 1994.
>
> The third set of documents discussed the investigation of a large fish kill that occurred between September 1, 1994 and September 6, 1994, on Bayou Dulac, Avoyelles Parish, Louisiana. The kill was attributed to azinphos methyl and resulted in .5,000 dead fish. The fish ranged in size from 8" to 36" and included a wide variety of species including Bowfin, Alligator gar, Crappie, Buffalo, Goo and Black bass. According to the investigation reports, lab records, statements and other information the chronology of the fish kill was as follows:

DATE	OCCURRENCE
08/22/94	Azinphos methyl applied to 495 acres of sugar cane located along Rt. 1, Bunkie, LA.. (Drainage from this field runs into Bayou Dulac)(Gulf Aviation records)
08/31/94	0.28" of rain recorded (Weather Service)
09/01/94	Azinphos methyl applied to 20 acres of sugar cane located next to drainage ditch on Hwy. 3041, one and one half miles from Bayou Dulac. (Vaughn Flying Service records) 0.62" of rain recorded (Weather Service)
09/02/94	First dead fish seen by fisherman (Pesticide Enforcement, Inspector's Summary of Investigation, E. P. Dubea) 0.67" of rain recorded (Weather Service)
09/03/94	Dead fish found by Glen Bordelon (Glen Bordelon Statement)
09/04/94	Fish kill reported to Jason Dewitt (LDEQ) by Glen Bordelon. Mr. Dewitt reports fish kill to Robert Willett (LDAF) (LDEQ and LDAF reports)
09/05/94	Fish kill investigation begins. Jason Dewitt (LDEQ), Robert Willett (LDAF) and Earl Dubea (LDAF) met at Bayou Dulac and investigated by boat and on foot. Found and estimated 1,000 dead fish of wide ranges of size and species. Water and sediment samples were collected by both LDAF and LDEQ. No fish samples were collected due to decomposition. (LDEQ and LDAF reports)
09/06/94	Jason Dewitt continued investigation by air and found an additional .4,000 dead fish covering .6 miles in Bayou Dulac including the town of Cottonport. (LDEQ and LDAF reports)
09/07/94	R. Willett, L. Hebert and E. Dubea, of LDAF, collect more water samples and sediment samples and obtain information from local aerial applicators regarding recent pesticide applications to areas draining into Bayou Dulac.(LDAF reports)
09/08/94	More information gathered regarding recent pesticide applications (LDAF reports)
09/12/94	Northeast Louisiana University, Soil-Plant Analysis Laboratory reports analysis of LDEQ water samples taken 09/05/94. Results show levels of Azinphos methyl of 2.1, 3.2 and 10.7 ppb. LSU/LDAF reports analysis of LDAF water samples taken 09/05/94. Results show levels of Azinphos methyl of 2.9, 2.9 and 2.2 ppb. Conclusions included with this analysis are as follows: "Results of the chemical evaluation of the water suggests that the cause of this fish kill event was related to the pesticide Azinphos methyl." (LC_{50} for fish .2.9)
09/15/94	LSU/LDAF reports analysis of LDAF water samples taken 09/07/94. Results show levels of Azinphos methyl of trace, trace and 0.17 ppb. Conclusions included with this analysis are as follows: "Results of the chemical evaluation of the water and soils suggests that the Azinphos methyl is no longer at concentrations high enough to cause fish mortality at this location. Report filed by Jason Dewitt (LDEQ) in which the following conclusion is reached: "I concluded that the cause of this fish kill was the result of pesticide runoff." The report then refers to the reasons for this conclusion, part of which was the presence of azinphos methyl.

DATE	OCCURRENCE
	undated report by E. P. Dubea (LDAF) indicated the following conclusion: "Large Bowfin did not die because of low oxygen; A non point source run off was the likely cause of the fish kill; Azinphos methyl was found in Bayou du Lac and in the drainage ditch that enters the Bayou next to the bridge on Hwy. 3041." The report then refers to the two Azinphos methyl applications shown above.

EEB Comments:

Regarding the "1994 Fish Kill Investigation"; The report lists 51 fish kills as having been caused b low D.O., however, there is no clarification in the report as to how this cause and effect was determined. Is it possible that instead of the low D.O. killing fish, the fish might have been kille pesticide runoff resulting in low D.O.? For example in the Opelousas fish kill (see above) the LDEQ concluded that the kill was caused by low D.O.. Only after the LDAF had examined the results of the water sample analysis did LDAF conclude that the kill was caused by pesticide drift from an aerial application. There is no indication that water samples were taken during the investigation of the 51 fish kills attributed to low D.O..

Regarding the fish kill in the pond in Opelousas, LA, EEB concurs with the conclusions reached by the LDAF. The fish kill was the result of off target drift from the aerial Azinphos methyl application t the sugar cane field north of the pond. This example clearly shows that fish kills may result solely from aerial application of azinphos methyl.

Regarding the fish kill in Bayou Dulac, LA, EEB concurs with the conclusions reached by both the LDAF LDEQ. EEB believes that the fish kill was the result of rain induced runoff of Azinphos methyl from nearby sugar cane fields following aerial application of Azinphos methyl. Significant amounts of azinphos methyl (residues greater than the LC_{50}s for fish), entered Bayou Dulac and caused the fish ki and resulted in the presence of aquatic residues ranging from 2.1 to 10.7 ppb three day after the run event occurred. The fact that a three day period occurred prior to the measurement of residues and t both degradation of the pesticide and dilution within the Bayou occurred during that period, infers t actual residues at the time the fish kill actually occurred may have been considerably greater. Beca of the large number of fish killed and the considerable variety of species involved, EEB considers th significant fish kill which requires serious attention."

4) 1987 GEORGIA Incidents

According to the Ecological Incident Information System there are listed aquatic Incidents that occur in Georgia in September and October of 1987. All of these were associated with aerially applied azin methyl (Guthion) to cotton. A total of 88 Incidents occurred in the following counties; Baker, Bleck Brooks, Calhoun, Colquitt, Cook, Crisp, Dodge, Dooly, Grady, Lanier, Laurens, Ocnee, Pulaski, Thomas, Tift, Turner, and Wilcox. The fish species affected were Bream, Bass and Catfish. Approximately the total number of fish affected were around 100,000 over this two month period. Additional terrestrial Incidents occurred in Brooks County. The animals affected were a cow, a pig, and a parakeet.

The investigative reports from the state of Georgia indicated the distance from the application site the Incidents site, the concentration of Guthion in the water body where the incidence took place, an foliar analysis of the vegetation surrounding the Incidents site. Guthion moved off the application from 20 to 3000 feet. Only on incident report indicated that there was precipitation after applicatio The analytical results that were reported in the 82 Incidents were; from 0.30 to 5.34 ppb in water, a 0.41 to 20.2 ppm on foliage.

Table 3: Azinphos methyl (Guthion) Georgia Incidents						
Incident No./ Date[1]	**Species**	**Effect/#**	**Crop/ Misuse/ Application Method**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
B-85 9/18/87	fish (Bream, Bass, Catfish)	2500	cotton aerial	GA	water	0.67 ppm and 1 ppb
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/5/87. Analysis reported date 9/21/87. Colquitt county, Moultrie, Ga.						
B-58 9/18/87	fish	2000	cotton aerial	GA	water	1.34
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/10/87. Analysis reported date 9/24/87. Brooks county, Pavo, Ga.						
B-59 9/17/87	fish	N/R	cotton aerial	GA	water	1.94
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/10/87. Analysis reported date 10/1/87. Thomas county, Thomasville, Ga.						
B-60 9/24/87	fish	2500	cotton aerial	GA	water	1.42 ppm & 0.67 ppb
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/12/87. Analysis reported date 10/13/87. Cook county, Lenox, Ga.						
B-61 9/24/97	fish	2000	cotton aerial	GA	water and grass	< 1 ppb and <1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/8/87. Analysis reported date 10/13/87. Cook county, Aldan, Ga.						

Table 3: Azinphos methyl (Guthion) Georgia Incidents

Incident No./ Date[1]	Species	Effect/#	Crop/ Misuse/ Application Method	St	Residue Analysis	
					Item	Conc. (ppb)
Comments						
B-62 9/24/87	fish	N/R ("large no. reported)	cotton aerial	GA	water	0.54
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/24/87. Analysis reported date 10/23/87. Dooly county, Vienna, Ga.						
B-63 and B-64 9/24/87	fish	unknown	cotton aerial	GA	Water Grass	0.4 ppb 2.17 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/13/87. Analysis reported date 10/23/87. Cook county, Sparks, Ga.						
B-65 9/24/97	bees	unknown	cotton aerial	GA	Grass	< 1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field. Exposure date 9/21/87. Analysis reported date 10/20/87. Cook county, Adel, Ga.						
B-66 9/25/87	plant	N/R	cotton aerial	GA	grass	15,703 ppm
Guthion dump - aircraft began running rough so pilot dumped 10 gallons of material for fear of crashing. Incident occurred in an unplanted area all living vegetation was killed in this area (75 ft. X 125 ft.). Dodge county, Eastman, GA.						
B-68 9/25/87	fish	1500	cotton aerial	GA	water	1.93 ppb
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/11/87. Analysis reported date 10/16/87. Cook county, Sparks, Ga.						

Table 3: Azinphos methyl (Guthion) Georgia Incidents						
Incident No./ Date[1]	**Species**	**Effect/#**	**Crop/ Misuse/ Application Method**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
B-69 9/28-29/87	fish	No. dead N/R	cotton aerial	GA	water	5.58 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/22/87. Analysis reported date 10/23/87. Bleckley county, Cochran, Ga.						
B-70 9/28/97	fish	No. dead N/R	cotton aerial	GA	grass	3.38 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/28/87. Analysis reported date 10/22/87. Cook county, Lennox, Ga.						
B-71 9/25/97	fish	No. dead N/R	cotton aerial	GA	water foliage	1.47 ppb, < 1ppm, and 1.05 ppb 1.47 ppm, and 0.5 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into three ponds. Exposure date 9/11/87. Analysis reported date 10/22/87. Cook county, Lennox, Ga.						
B-90 9/21/87	fish	2000	cotton aerial	GA	water	<1 ppb
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/21/87. Analysis reported date 10/23/87. Dooly county, Pinehurst, Ga.						
B-91 9/22/97	Bream Bass	300	cotton aerial	GA	water grass	1.38 ppb 0.56 ppm

Table 3: Azinphos methyl (Guthion) Georgia Incidents						
Incident No./ Date[1]	**Species**	**Effect/#**	**Crop/ Misuse/ Application Method**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/13/87. Analysis reported date 10/14/87. Colquitt county, Moultrie, Ga. Boll Weevil Eradication Program						
B-92 9/22/97	fish	60% - 70% of the fish were dead	cotton aerial	GA	water grass	0.45 ppb 1.50 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/13/87. Analysis reported date 10/14/87. Lanier county, Lakeland, Ga.						
B-93 9/15/87	fish	No. killed N/R	cotton aerial	GA	water grass	1 ppb <1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/9/87. Analysis reported date 9/23/87. Brooks, county, Hahira, Ga.						
B-94 9/23-25/87	Bass Bream	No. killed N/R	cotton aerial	GA	water grass	<1 ppb 2.58 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/14/87 and 9/17/87. Analysis reported date 9/24/87. Laurens, county, Dublin, Ga.						
B-95 9/22/87	Bream	4000	cotton aerial	GA	water grass	0.64 ppb 0.44 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/8/87. Analysis reported date 10/16/87. Laurens, county, Dublin, Ga.						
B-96 9/23/87	Bass Bream	10000 to 12000	cotton aerial	GA	water grass	< 1 ppb 0.95 ppm

Table 3: Azinphos methyl (Guthion) Georgia Incidents						
Incident No./ Date[1]	**Species**	**Effect/#**	**Crop/ Misuse/ Application Method**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/5/87. Analysis reported date 10/16/87. Tift, county, Tifton, Ga.						
B-97 10/6/97	Bass Bream	500 to 600	cotton aerial	GA	water grass	1.38 ppb 5.13 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 10/5/87. Analysis reported date 10/23/87. Colquitt, county, Moultrie, Ga.						
B-98 9/29/87	fish	3	cotton aerial	GA	water grass	1.31 ppb 3.03 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 10/5/87. Analysis reported date 10/23/87. Tift, county, Tifton, Ga. Boll Weevil Eradication Program						
B-99 10/2/87	fish	2000	cotton aerial	GA	water grass	0.63 ppb 0.88 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/22/87. Analysis reported date 10/22/87. Brooks, county, Marven, Ga. Boll Weevil Eradication Program						
B-100 9/29/87	Bass Bream	100% kill of fish in pond	cotton aerial	GA	water grass	0.61 ppb 1.98 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/24/87. Analysis reported date 10/22/87. Brooks, county, Quitman, Ga. Boll Weevil Eradication Program						
B-101 9/29/87	Bass Bream	30	cotton aerial	GA	water grass	0.59 ppb 1.37 ppm

Table 3: Azinphos methyl (Guthion) Georgia Incidents						
Incident No./ Date[1]	**Species**	**Effect/#**	**Crop/ Misuse/ Application Method**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 9/26/87. Analysis reported date 10/22/87. Brooks, county, Quitman, Ga. Boll Weevil Eradication Program						
B-102 10/13/87	fish	8-10	cotton aerial	GA	water grass	0.71 ppb 2.26 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 10/9/87. Analysis reported date 10/23/87. Cook, county, Adel, Ga.						
B-103 10/16/97	fish	hundreds	cotton aerial	GA	water grass	0.59 ppb 1.54 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 10/1/87. Analysis reported date 10/23/87. Thomas, county, Meigs, Ga.						
B-104 10/20/87	fish	No. of fish N/R	cotton aerial	GA	water grass	1.21 ppb 0.89 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Analysis reported date 10/9/87. Cook, county, Lenox, Ga.						
B-105 10/27/87	fish	hundreds	cotton aerial	GA	water grass	1.52 ppb 3.52 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 10/25/87. Analysis reported date 11/4/87. Brooks, county, Morvan, Ga. Boll Weevil Eradication Program						
B-106 10/27/87	Bass Bream	thousands	cotton aerial	GA	water grass	11 ppb 12.2 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 10/19/87. Analysis reported date 11/4/87. Baker, county, Newton, Ga.						

Table 3: Azinphos methyl (Guthion) Georgia Incidents

Incident No./ Date[1]	Species	Effect/#	Crop/ Misuse/ Application Method	St	Residue Analysis	
					Item	Conc. (ppb)
Comments						
B-107 10/28/87	fish (Bass, Bream)	No. of fish killed N/R	cotton aerial	GA	water grass	2.36 ppb 29.2 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 10/19/87. Analysis reported date 11/4/87. Watkins, Ga.						
B-108	Bass Bream	125	cotton aerial	GA	water grass	1.56 ppb 4.19 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 10/15/87. Analysis reported date 11/4/87. Thomas county, Coolidge, Ga.						
B-109 10/29/87	Bass Bream	No. of fish killed N/R	cotton aerial	GA	water grass	1.87 ppb 3.40 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 10/26/87. Analysis reported date 11/4/87. Calhoun county, Morgan, Ga.						
B-110 10/30/87	Bass Bream	No. of fish killed N/R	cotton aerial	GA	water grass	1.65 ppb 28.6 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 10/26/87. Analysis reported date 11/4/87. Calhoun county, Morgan, Ga.						
B-111 11/3/87	Bass Bream	several	cotton aerial	GA	water grass	1.3 ppb 7.11 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 10/27/87. Turner county, Sycamore, Ga.						
B-112 11/4/97	Bass	several	cotton aerial	GA	water grass	1.09 ppb 7.9 ppm

Table 3: Azinphos methyl (Guthion) Georgia Incidents						
Incident No./ Date[1]	**Species**	**Effect/#**	**Crop/ Misuse/ Application Method**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 10/27/87. Colquitt county, Doerun, Ga. Boll Weevil Eradication Program.						
B-113 11/4/87	Bass Bream	No. of fish killed N/R	cotton aerial	GA	water grass	2.38 ppb 8.94 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 11/1/87. Pulaski county, Hawkinsville, Ga. Boll Weevil Eradication Program.						
B-114 11/23/87	bird- parakeet	1	cotton aerial	GA	grass	<1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Exposure date 11/20/87. Brooks county, Pavo, Ga.						
B-115 10/6/87	fish (Bream)	thousands	cotton aerial	GA	water foliage	0.48 ppb 3.49 ppm
The cause was allegedly due pesticide contamination in the pond. Calhoun county, Edison, Ga.						
B-72 9/18/87	fish	No. of dead fish N/R	cotton aerial	GA	water foliage	<1 ppb 4.25 ppm
Fish kill occurred in a pond that was surrounded by cotton fields. Cotton comes to within 50 feet of the pond. Tift county, Tifton, Ga.						
B-73 9/18/97	fish	No. of dead fish N/R	cotton aerial	GA	water	2.93 ppb
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Dooly county, Lily, Ga.						
B-74 9/19/87	fish	complete kill of all fish in pond	cotton aerial	GA	water grass	<1 ppb <1 ppm

Table 3: Azinphos methyl (Guthion) Georgia Incidents						
Incident No./ Date[1]	**Species**	**Effect/#**	**Crop/ Misuse/ Application Method**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Sparks, Ga.						
B-77 9/17/87	fish	No. of dead fish N/R	cotton aerial	GA	water grass	1.08 ppb 1.39 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Crisp county, Arabi, Ga.						
B-78 9/17/87 and 10/19/87	fish	No. of dead fish N/R	cotton aerial	GA	water grass	0.9 ppb <1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Sparks, Ga.						
B-86 9/21/87	fish	100% fish killed in pond	cotton aerial	GA	water grass	2.25 ppb 3.93 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Sparks, Ga. Boll Weevil Eradication Program.						
B-87 9/21/87	fish (bass and bream)	thousands	cotton aerial	GA	water grass	1.53 ppb 1.65 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Sparks, Ga. Boll Weevil Eradication Program.						
B-88 9/21/87	fish (bass and bream)	2000	cotton aerial	GA	water grass	<1 ppb <1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Colquitt county, Ellenton, Ga.						

Table 3: Azinphos methyl (Guthion) Georgia Incidents						
Incident No./ Date[1]	**Species**	**Effect/#**	**Crop/ Misuse/ Application Method**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
B-57 9/18/87	fish	thousands	cotton aerial	GA	water grass	0.47 ppb <1 ppm
The cause was allegedly due to drift from aerial application from neighboring cotton fields into two ponds. Thomas county, Meigs, Ga. Boll Weevil Eradication Program.						
B-84 9/17/87	fish	complete kill of all fish in pond	cotton aerial	GA	water grass	<1 ppb 0.71 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Lanier county, Lakeland, Ga.						
B-83 9/18/87	fish	several	cotton aerial	GA	water grass	0.78 ppb 3.17 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Colquitt county, Moultrie, Ga. Boll Weevil Eradication Program.						
B-82 9/21/87	fish	100% kill of all scale fish	cotton aerial	GA	water grass	1.30 ppb 2.32 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Lenox, Ga.						
B-81 9/18/87	fish	100% kill of all scale fish	cotton aerial	GA	water grass	0.96 ppb <1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Sparks, Ga.						
B-80 9/17/87 and 10/19/87	fish	No. of fish killed N/R	cotton aerial	GA	water grass	0.42 ppb <1 ppm

Table 3: Azinphos methyl (Guthion) Georgia Incidents						
Incident No./ Date[1]	**Species**	**Effect/#**	**Crop/ Misuse/ Application Method**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Sparks, Ga.						
B-52 9/17/87	fish (bass and bream - all sizes)	hundreds	cotton aerial	GA	water grass	0.54 ppb 4.95 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Colquitt county, Norman Park, Ga.						
B-29 9/16/87	fish (all sizes)	thousands	cotton aerial	GA	water grass	<1 ppb 1.03 ppm
Allegedly the pesticide was sprayed over the pond. Brooks county, Barney, Ga.						
B-28 9/15/87	fish	100% death of scale fish	cotton aerial	GA	water	1.04 ppb
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Tift county, Tifton, Ga.						
B-27 9/17/87 and 10/19/87	fish	No. of fish killed N/R	cotton aerial	GA	water grass	0.71 ppb 0.41 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Sparks, Ga.						
B-24 9/14/87	fish	hundreds	cotton aerial	GA	water grass	1.08 ppb 1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton fields into ponds. Birds observed feeding on the dead fish. Brooks county, Barney, Ga.						

Table 3: Azinphos methyl (Guthion) Georgia Incidents						
Incident No./ Date[1]	Species	Effect/#	Crop/ Misuse/ Application Method	St	Residue Analysis	
					Item	Conc. (ppb)
Comments						
B-23 9/14/87	fish	complete kill of scale fish	cotton aerial	GA	water grass	1.46 ppb 2.43
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Adel, Ga.						
B-22 9/14/87	fish (bream)	400-500	cotton aerial	GA	water grass	<1 ppb <1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Brooks county, Morven, Ga. Boll Weevil Eradication Program.						
B-45 9/15/87	fish	complete kill of scale fish	cotton aerial	GA	water grass	1.2 ppb 1.98 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Adel, Ga.						
B-42 9/18/87	fish	Several hundred	cotton aerial	GA	water grass	2.68 ppb 4.78 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Lenox, Ga. Boll Weevil Eradication Program.						
B-41 9/18/87	fish	200	cotton aerial	GA	water grass	<1 ppb 1.46 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Barney, Ga.						
B-40 9/17/87	bream and bass	2000	cotton aerial	GA	water grass	<1 ppb <1 ppm

Table 3: Azinphos methyl (Guthion) Georgia Incidents						
Incident No./ Date[1]	**Species**	**Effect/#**	**Crop/ Misuse/ Application Method**	**St**	**Residue Analysis**	
					Item	**Conc. (ppb)**
Comments						
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Brooks county, Pavo, Ga. Boll Weevil Eradication Program.						
B-31 9/11/87	bream and bass	thousands	cotton aerial	GA	water grass	5.48 ppb <1 ppm
The cause was allegedly from over-spraying a pond during aerial application of a neighboring cotton field. Brooks county, Morven, Ga.						
B-30 9/11/87	fish	100% kill of scale fish	cotton aerial	GA	water	2.34 ppb
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Adel, Ga. Boll Weevil Eradication Program.						
B-32 9/14/87	fish	100% kill of scale fish	cotton aerial	GA	water grass	1.0 ppb 3.53 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Adel, Ga. Boll Weevil Eradication Program.						
B-34 9/11/87	fish	severe kill	cotton aerial	GA	water	2.20 ppb
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Marven, Ga.						
B-35 9/11/87	fish	No. of dead fish N/R	cotton aerial	GA	water	1.15 ppb
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Lenox, Ga. Boll Weevil Eradication Program.						
B-36 9/11/87	fish	few	cotton aerial	GA	water	1.48 ppb

Table 3: Azinphos methyl (Guthion) Georgia Incidents

Incident No./ Date[1]	Species	Effect/#	Crop/ Misuse/ Application Method	St	Residue Analysis	
					Item	Conc. (ppb)
Comments						
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Brooks county, Barney, Ga.						
B-43 9/15/87	fish (bream)	several	cotton aerial	GA	water grass	<1 ppb <1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Brooks county, Barney, Ga.						
B-25 9/14/87	bass bream	Several thousand	cotton aerial	GA	water grass	1.41 ppb 2.53 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Brooks county, Barney, Ga.						
B-49 9/11/87	bream bass	several	cotton aerial	GA	water	<1 ppb
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Brooks county, Barney, Ga.						
B-89 9/21/87	bass bream catfish	10,000	cotton aerial	GA	water grass	<1 ppb 0.72 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Colquitt county, Norman Park, Ga. Boll Weevil Eradication Program.						
B-76 9/17/87	fish	1,000	cotton aerial	GA	water	0.57 ppb
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Tift county, Tifton, Ga.						

Table 3: Azinphos methyl (Guthion) Georgia Incidents

Incident No./ Date[1]	Species	Effect/#	Crop/ Misuse/ Application Method	St	Residue Analysis	
					Item	Conc. (ppb)
Comments						
B-67 9/25/87	bass bream catfish	10,000	cotton aerial	GA	water grass	0.39 ppb 0.54 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cook county, Lenox, Ga. Boll Weevil Eradication Program.						
B-26 9/17/87	bass bream catfish	2,000	cotton aerial	GA	water grass	2.24 ppb 1.48 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Brooks county, Marven, Ga. Boll Weevil Eradication Program.						
B-48 9/28-29/87	fish	No. of dead fish N/R	cotton aerial	GA	water grass	<1 ppb 5.58 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Cochran, Ga. Report indicated that "appear as all scale fish dead."						
B-75 9/18/87	fish	No. of dead fish N/R	cotton aerial	GA	water grass	<1 ppb <1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Colquitt county, Ga. Report indicated that "appear as all scale fish dead."						
B-21 9/16/87	fish	thousands (alleged)	cotton aerial	GA	water grass	<1 ppb <1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Brooks county, Barney, Ga.						
B-46 9/15/97	fish	No. of dead fish N/R	cotton aerial	GA	water grass	0.86 ppb <1 ppm

Table 3: Azinphos methyl (Guthion) Georgia Incidents						
Incident No./ Date[1]	Species	Effect/#	Crop/ Misuse/ Application Method	St	Residue Analysis	
					Item	Conc. (ppb)
Comments						
The cause was allegedly due to runoff from a heavy rain, from a neighboring cotton field into a pond. Wilcox county, Abbeville, Ga. Boll Weevil Eradication Program.						
B-47 9/16/87	fish	No. of dead fish N/R	cotton aerial	GA	water grass	5.34 ppb 6.51 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Turner county, Sycamore, Ga. Report noted a "complete kill"						
B-50 9/18/87	bass bream catfish	several thousand	cotton aerial	GA	water grass	<1 ppb <1 ppm
The cause was allegedly due to drift from aerial application from a neighboring cotton field into a pond. Brooks county, Pavo, Ga.						

1 Date is date on investigation

APPENDIX II

The following lists of endangered species were obtained from the EFED Endangered Species Data Base (updated 10/1/92).

Endangered Fish Species

Apples: Alabama Sturgeon, Gulf Sturgeon, Pallid Sturgeon, Shortnose Sturgeon, Goldline Darter, Cahaba Shiner, Pygmy Sculpin, Blue Shiner, Alabama Cavefish, Snail Darter, Watercress Darter, Slackwater Darter, Boulder Darter, Loach Minnow, Little Colorado Spinedace, Apache Trout, Yaqui Catfish, Yaqui Chub, Desert Pupfish, Beautiful Shiner, Gila (Yaqui) Topminnow, Humpback Chub, Razorback Sucker, Colorado Squawfish, Spikedace, Ozark Cavefish, Leopard Darter, Chinook Salmon (Snake River Spring/Summer & Winter Run), Lahontan Cutthroat Trout, Little Kern Golden Trout, Paiute Cutthroat Trout, Owens Tui Chub, Owens Pupfish, Sacramento Splittail, Modoc Sucker, Mohave Tui Chub, Bonytail Chub, Delta Smelt, Unarmored Threespine Stickleback, Greenback Cutthroat Trout, Cherokee Darter, Etowah Darter, Amber Darter, Conasauga Logperch, Goldline Darter, Snake River Sockeye Salmon, Neosho Madtom, Blackside Dace, Maryland Darter, Bayou Darter, Niangua Darter, Pahrump Poolfish, Ash Meadows Amagosa Pupfish, Devils Hole Pupfish, Warm Springs Pupfish, White River Spinedace, Railroad Valley Springfish, Cui-ui, Warner Sucker, Pahrump Killifish, Rio Grande Silvery Minnow, Pecos Gambusia, Bluntnose Pecos Shiner, Chihuahua Chub, Gila Trout, Cape Fear Shiner, Spotfin Chub, Scioto Madtom, Leopard Darter, Oregon Chub, Lost River Sucker, Shortnose Sucker, Hutton Tui Chub, Foskett Speckled Dace, Smoky Madtom, Yellowfin Madtom, Slender Chub, Duskytail Darter, Fountain Darter, San Marcos Gambusia, Comanche Springs Pupfish, June Sucker, Virgin River Chub, Woundfin, Roanoke Logperch.

Pears: Alabama Sturgeon, Gulf Sturgeon, Pygmy Sculpin, Blue Shiner, Snail Darter, Goldline Darter, Cahaba Shiner, Yaqui Catfish, Yaqui Chub, Desert Pupfish, Beautiful Shiner, Gila (Yaqui) Topminnow, Loach Minnow, Colorado Squawfish, Razorback Sucker, Humpback Chub, Little Colorado Spinedace, Apache Trout, Spikedace, Ozark Cavefish, Leopard Darter, Chinook (Winter-Run) Salmon, Lahontan Cutthroat Trout, Little Kern Golden Trout, Paiute Cutthroat Trout, Sacramento Splittail, Mohave Tui Chub, Unarmored Threespine Stickleback, Owens Tui Chub, Owens Pupfish, Bonytail Chub, Desert Pupfish, Delta Smelt, Lost River Sucker, Shortnose Sturgeon, Okaloosa Darter, Amber Darter, Conasauga Logperch, Cherokee Darter, Etowah Darter, Chinook (Snake River Spring/Summer) Salmon, Chinook Salmon, Snake River Sockeye Salmon, Pallid Sturgeon, Bayou Darter, Cui-ui, Warner Sucker, Rio Grande Silvery Minnow, Chihuahua Chub, Gila Trout, Cape Fear Shiner, Oregon Chub, Snail Darter, Smoky Madtom, Yellowfin Madtom, Boulder Darter, Slender Chub, Slackwater Darter, Spotfin Chub, June Sucker, Virgin River Chub, Woundfin, Roanoke Logperch.

Almonds: Desert Pupfish, Gila (Yaqui) Topminnow, Chinook (Snake River Spring/Summer) Salmon, Chinook (Winter Run) Salmon, Lahontan Cutthroat Trout, Little Kern Golden Trout, Paiute Cutthroat Trout, Sacromento Splittail, Mohave Tui Chub, Unarmored Threespine Stickleback, Delta Smelt, Bonytail Chub, Desert Pupfish, Colorado Squawfish, Razorback Sucker, Little Kern Golden Trout, Oregon Chub, Snake River Sockeye Salmon,

Cotton: Alabama Sturgeon, Gulf Sturgeon, Pygmy Sculpin, Blue Shiner, Alabama Cavefish, Watercress Darter, Slackwater Darter, Boulder Darter, Snail Darter, Goldline Darter, Cahaba Darter, Yaqui Catfish, Yaqui Chub, Desert Pupfish, Beautiful Shiner, Gila (Yaqui) Topminnow, Loach Minnow, Desert Pupfish, Spikedace, Razorback Sucker, Apache Trout, Bonytail Chub, Humpback Chub, Virgin River Chub, Pallid Sturgeon, Little Kern Golden Trout, Paiute Cutthroat Trout, Colorado Squawfish, Lahontan Cutthroat Trout, Okaloosa Darter, Shortnose Sturgeon, Cherokee Darter, Etowah Darter, Pallid Sturgeon, Bayou Darter, Cape Fear Shiner, Fountain Darter, Rio Grande Silvery Minnow, Pecos Gambusia, Leon Springs Pupfish, Comanche Springs Pupfish, Roanoke Logperch.

Cherries: Snail Darter, Yaqui Catfish, Yaqui Chub, Desert Pupfish, Beautiful Shiner, Gila (Yaqui) Topminnow, Humpback Chub, Loach Minnow, Little Colorado Spinedace, Apache Trout, Spikedace, Colorado Squawfish, Razorback Sucker, Gila Trout, Ozark Cavefish, Chinook (Snake River Spring/Summer) Salmon, Chinook (Winter Run) Salmon, Lahontan Cutthroat Trout, Little Kern Golden Trout, Paiute Cutthroat Trout, Mohave Tui Chub, Unarmored Threespine Stickleback, Bonytail Chub, Delta Smelt, Lost River Sucker, Greenback Cutthroat Trout, Shortnose Sturgeon, Chinook Salmon, Snake River Sockeye Salmon, Blackside Dace, Maryland Darter, Pallid Sturgeon, Virgin River Chub, Moapa Dace, Pahrump Killifish, Devils Hole Pupfish, Woundfin, Rio Grande Silvery Minnow, Pecos Gambusia, Pecos Bluntnose Shiner, Chihuahua Chub, Loach Minnow, Beautiful Shiner, Gila Trout, Cape Fear Shiner, Oregon Chub, Smoky Madtom, Yellowfin Madtom, Boulder Darter, Spotfin Chub, Humpback Chub, June Sucker, Roanoke Logperch.

Peaches: Alabama Sturgeon, Gulf Sturgeon, Pygmy Sculpin, Blue Shiner, Alabama Cavefish, Watercress Darter, Snail Darter, Slackwater Darter, Boulder Darter, Goldline Darter, Cahaba Shiner, Yaqui Catfish, Yaqui Chub, Desert Pupfish, Beautiful Shiner, Gila (Yaqui) Topminnow, Loach Minnow, Colorado Squawfish, Razorback Sucker, Humpback Chub, Little Colorado Spinedace, Apache Trout, Spikedace, Gila Trout, Ozark Cavefish, Leopard Darter, Chinook (Snake River Spring/Summer) Salmon, Chinook (Winter Run) Salmon, Lahontan Cutthroat Trout, Little Kern Golden Trout, Paiute Cutthroat Trout, Owens Tui Chub, Owens Pupfish, Sacramento Splittail, Mohave Tui Chub, Unarmored Threespine Stickleback, Bonytail Chub, Delta Smelt, Lost River Sucker, Greenback Cutthroat Trout, Shortnose Sturgeon, Okaloosa Darter, Amber

Darter, Cherokee Darter, Etowah Darter, Goldline Darter, Chinook Salmon, Pallid Sturgeon, Neosho Madtom, Relict Darter, Blackside Dace, Maryland Darter, Bayou Darter, Niangua Darter, Virgin River Chub, Moapa Dace, Pahrump Killifish, Devils Hole Pupfish, Rio Grande Silvery Minnow, Pecos Gambusia, Pecos Bluntnose Shiner, Chihuahua Chub, Cape Fear Shiner, Scioto Madtom, Oregon Chub, Snake River Sockeye Salmon, Smoky Madtom, Yellowfin Madtom, Conasauga Logperch, Slender Chub, Spotfin Chub, Duskytail Darter, Big Bend Gambusia, Fountain Darter, Rio Grande Silvery Minnow, San Marcos Gambusia, June Sucker, Woundfin, Roanoke Logperch.

Plums: Blue Shiner, Snail Darter, Yaqui Catfish, Yaqui Chub, Desert Pupfish, Beautiful Shiner, Gila (Yaqui) Topminnow, Loach Minnow, Spike dace, Razorback Sucker, Apache Trout, Humpback Chub, Little Colorado Spinedace, Spikedace, Chinook (Winter Run) Salmon, Lahontan Cutthroat Trout, Little Kern Golden Trout, Paiute Cutthroat Trout, Sacramento Splittail, Mohave Tui Chub, Unarmored Threespine Stickleback, Bonytail Chub, Colorado Squawfish, Delta Smelt, Greenback Cutthroat Trout, Shortnose Sturgeon, Chinook (Snake River Spring/Summer) Salmon, Blackside Dace, Gulf Sturgeon, Bayou Darter, Virgin River Chub, Moapa Dace, Pahrump Killifish, Devils Hole Pupfish, Razorback Sucker, Woundfin, Rio Grande Silvery Minnow, Gila Trout, Shortnose Sturgeon, Cape Fear Shiner, Oregon Chub, Snake River Sockeye Salmon, Smoky Madtom, Yellowfin Madtom, Slackwater Darter, Spotfin Chub, Boulder Darter, Pallid Sturgeon, Fountain Darter, San Marcos Gambusia, June Sucker, Roanoke Logperch.

Endangered Aquatic Invertebrate Species

Apples: Alabama Cave Shrimp, Cave Crayfish, California Linderella, Longhorn Fairy Shrimp, Vernal Pool Fairy Shrimp, Conservancy Fairy Shrimp, Vernal Pool Tadpole Shrimp, California Freshwater Shrimp, Riverside Fairy Shrimp, Squirrel Chimney Cave Shrimp, Kentucky Cave Shrimp, Socorro Isopod, Nashville Crayfish, Madison Cave Isopod, Lee County Cave Isopod, Alabama Cave Shrimp.

Pears: California Linderella, Vernal Pool Tadpole Shrimp, Longhorn Fairy Shrimp, Vernal Pool Fairy Shrimp, Conservancy Fairy Shrimp, Riverside Fairy Shrimp, Shasta Crayfish, Squirrel Chimney Cave Shrimp, Nashville Crayfish, San Diego Fairy Shrimp.

Almonds: California Linderella, Vernal Pool Tadpole Shrimp, Longhorn Fairy Shrimp, Vernal Pool Fairy Shrimp, Conservancy Fairy Shrimp, Shasta Crayfish.

Cotton: Alabama Cave Shrimp, San Xavier Talus Snail, California Linderella, Vernal Pool Fairy Shrimp, Riverside Fairy Shrimp.

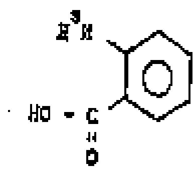
Cherries: Alabama Cave Shrimp, Conservancy Fairy Shrimp, Longhorn Fairy Shrimp, California Linderella, Vernal Pool Fairy Shrimp, Vernal Pool Tadpole Shrimp, California Freshwater Shrimp, Shasta Crayfish, Madison Cave Isopod.

Peaches: Alabama Cave Shrimp, Cave Crayfish, Conservancy Fairy Shrimp, Longhorn Fairy Shrimp, California Linderella, Vernal Pool Fairy Shrimp, Vernal Pool Tadpole Shrimp, California Freshwater Shrimp, Riverside Fairy Shrimp, Shasta Crayfish, Squirrel Chimney Cave Shrimp, Kentucky Cave Shrimp, Socorro Isopod, Nashville Crayfish, Madison Cave Isopod.

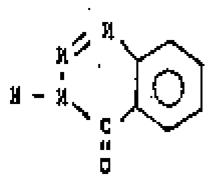
Plums: Alabama Cave Shrimp, Conservancy Fairy Shrimp, Vernal Pool Tadpole Shrimp, Longhorn Fairy Shrimp, California Linderella, Vernal Pool Fairy Shrimp, Riverside Fairy Shrimp, Nashville Crayfish.

Appendix III

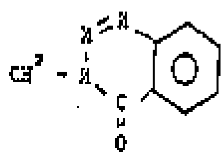
Chemical Structures for Azinphos Methyl and Degradates



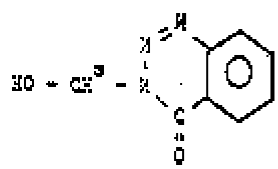
Azinphos methyl



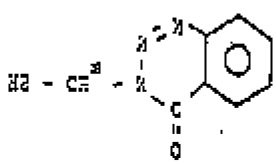
Azinphos methyl oxygen analog



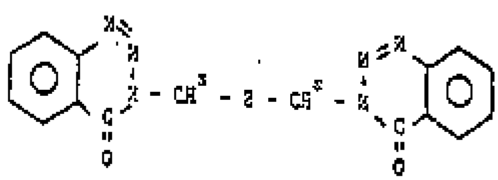
bis-methyl benzazimide sulfide



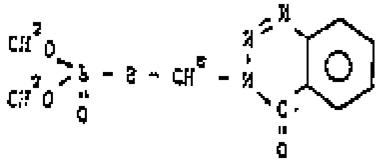
mercaptomethyl benzazimide



hydroxymethyl benzazimide



methyl benzazimide



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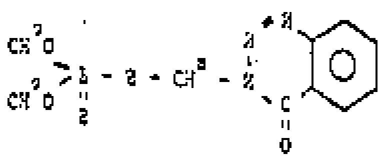

anthranilic acid

Appendix IV
Data Summaries For Selected NAWQA Units

Table IV-1. Monitoring Data Summary for the NAWQA Central Columbia Plateau Study nit.

Site Name	Start Date	End Date	Number of Samples	Number of Detects	Peak	TWOM
SAND HOLLOW AT CR S SW NR VANTAGE, WA	04/14/94	02/14/96	6	0		
CRAB CREEK AT MARCELLUS ROAD NR RITZVILLE, WA	04/05/93	02/15/95	22	1	0.039	0.001556
FRENCHMAN HILLS WSTWY ON SE C RD NR MOSES LK, WA	04/11/94	02/15/95	5	0		
LIND COULEE WASTEWAY AT SR17 NR WARDEN, WA*	04/08/94	02/27/96	8	0		
POTHOLES CANAL AT ROAD K.2 NEAR WARDEN, WA	10/19/94	10/19/94	1	0		
SCBID MATTAWA WASTEWAY NR MATTAWA, WA*	04/15/94	07/15/95	8	3	0.1	0.044
CRAB CREEK AT MORGAN LAKE ROAD NEAR OTHELLO, WA	05/05/94	05/23/94	2	1	0.054	
CRAB CR NR OTHELLO,WASH	05/24/94	05/24/94	1	0		
CRAB CR LATERAL AB ROYAL LAKE NR OTHELLO, WA	03/31/93	07/18/95	37	16	0.2	0.021
CRAB CREEK AT B SE ROAD NEAR ROYAL CITY, WA	05/24/94	05/24/94	1	0		
CRAB CREEK NEAR SMYRNA, WASH.	05/24/94	05/24/94	1	0		
CRAB CR NR BEVERLY, WASH.	04/13/94	02/14/95	6	0		
SCBID SADDLE MOUNTAIN WASTEWAY NR MATTAWA, WA	02/27/96	02/27/96	1	0		
SCBID PE 16.4 WASTEWAY NR MOUTH NR RINGOLD, WA	04/04/94	02/28/96	9	2	0.057	0.011
EL 68 D WASTEWAY NEAR OTHELLO, WASH	04/01/93	02/28/96	31	4	0.5	0.015
ESQUATZEL DIV CHANNEL BL HEADWORKS NR PASCO, WA	04/05/94	02/27/96	6	0		
PALOUSE RIVER NEAR COLFAX, WASH.	04/14/94	07/24/95	5	0		
PARADISE CREEK AT PULLMAN, WASH.	04/20/94	04/20/94	1	0		
S.F. PALOUSE RIVER AT COLFAX, WA	04/12/94	07/24/95	5	0		
REBEL FLAT CREEK AT WINONA, WA	04/12/94	07/06/95	5	0		
PINE CREEK AT PINE CITY ROAD AT PINE CITY, WA	04/13/94	06/15/94	5	0		
ROCK CR NR WINONA,WASH.	04/21/94	04/21/94	1	0		
UNION FLAT CREEK NEAR COLFAX, WASH.	04/20/94	04/20/94	1	0		
UNION FLAT CR NR LACROSSE,WASH.	04/21/94	04/21/94	1	0		
PALOUSE RIVER AT HOOPER, WA	03/25/93	12/09/96	46	0		
UNNAMED CR AT RD B SE NR ROYAL CITY, WA	05/24/94	05/24/94	1	0		
CRAB CR WASTEWAY AT HWY 26 NR OTHELLO, WA	05/24/94	05/24/94	1	0		
DCC1 DRAIN AT RED ROCK COULEE RD NR ROYAL CITY, WA	05/24/94	05/24/94	1	0		
CRAB CR LATERAL AT DODSON RD NR ROYAL CITY, WA	05/23/94	05/23/94	1	1	0.073	
WEST CANAL AT H ROAD SE NR ROYAL CAMP, WA	05/25/94	05/25/94	1	0		
PALOUSE RIVER AT LAIRD PARK NR HARVARD, ID	04/19/94	05/02/94	2	0		
PALOUSE R. AT ENDICOTT-ST. JOHN RD NR COLFAX, WA	04/21/94	04/21/94	1	0		
W645WW AT RD I SW NR GEORGE, WA	04/26/94	02/28/96	2	0		
DW239 DRAIN AT RD M NW NR GEORGE, WA	04/26/94	04/26/94	1	0		
DW238 DRAIN AT HWY 283 NR QUINCY, WA	04/26/94	04/26/94	1	0		
W645 WW AT RD 5 NW NR QUINCY, WA	04/26/94	04/26/94	1	0		
W645W DRAIN AT RD M NW NR QUINCY, WA	04/26/94	04/26/94	1	0		
W645 WW AR RD 8 NW NR QUINCY, WA	04/26/94	04/26/94	1	0		
MAIN CANAL AT J ROAD NE NR STRATFORD, WA	05/25/94	05/25/94	1	0		

Table IV-2. Monitoring data summary from the NAWQA Potomac Basin Study Unit.

Site Code	Site Name	Start Date	End Date	Number of Samples	Number of Detects	Max Conc.	TWOM
01600000	NB POTOMAC R AT PINTO, MD	06/06/94	06/06/94	1	0		
01601470	PINEY MOUNTAIN C AT LAVALE, MD	08/08/95	08/08/95	1	0		
01603000	NB POTOMAC R NR CUMBERLAND, MD	06/06/94	06/06/94	1	0		
01604400	MILL C AT BURLINGTON, WV	08/08/95	08/08/95	1	0		
01605220	W STRAIT C NR MONTEREY, VA	08/09/95	08/09/95	1	0		
01605490	THORN C NR MOATSTOWN, WV	08/09/95	08/09/95	1	0		
01605800	DRY RN NR CHERRY GROVE, WV	08/09/95	08/09/95	1	0		
01605900	SENECA C NR ONEGO, WV	08/10/95	08/10/95	1	0		
01605950	JORDAN RN NR HOPEVILLE, WV	08/10/95	08/10/95	1	0		
01606500	SO. BRANCH POTOMAC R NR PETERSBURG, WV	06/05/94	06/05/94	1	0		
01606600	SF LUNICE C NR MAYSVILLE, WV	08/10/95	08/10/95	1	0		
01606720	N MILL C NR PETERSBURG, WV	08/10/95	08/10/95	1	0		
01608000	SO FK SOUTH BRANCH POTOMAC R NR MOOREFIELD, WV	06/05/94	08/22/95	3	0		
01608150	MUDLICK RN NR MOOREFIELD, WV	08/10/95	08/10/95	1	0		
01608300	MILL RN NR ROMNEY, WV	08/08/95	08/08/95	1	0		
01608500	SB POTOMAC R NR SPRINGFIELD, WV	06/06/94	09/09/96	4	0		
01610063	WHITE SULFUR RN NR FLINTSTONE, MD	08/09/95	08/09/95	1	0		
01610185	KIMSEY RN NR LOST RIVER, WV	08/11/95	08/11/95	1	0		
01610250	TROUT RN NR WARDENSVILLE, WV	08/09/95	08/09/95	1	0		
01610990	DILLONS RN AT CAPON BRIDGE, WV	08/09/95	08/09/95	1	0		
01611120	SPERRY RN AT RIO, WV	08/09/95	08/09/95	1	0		
01611130	TEAR COAT C NR RIO, WV	08/09/95	08/09/95	1	0		
01611205	MAPLE RN NR SLANESVILLE, WV	08/09/95	08/09/95	1	0		
01611500	CACAPON R NR GREAT CACAPON, WV	06/07/94	06/07/94	1	0		
01613060	CUMMINGS RN NR NEEDMORE, PA	08/10/95	08/10/95	1	0		
01613082	COVE RN AT WARFORDSBURG, PA	08/10/95	08/10/95	1	0		
01613510	L COVE C NR SYLVAN, PA	08/10/95	08/10/95	1	0		

01614010	HARLAN RN NR SPRING MILLS, WV	09/08/93	09/08/93	1	0	
01614110	CONOCOCHEAGUE C TR AT FAYETTEVILLE, PA	09/15/93	09/15/93	1	0	
01614130	FALLING SPRING AT CHAMBERSBURG, PA	09/07/93	09/07/93	1	0	
01614350	WELSH RN AT WELSH RUN, PA	09/15/93	09/15/93	1	0	
01614500	CONOCOCHEAGUE C AT FAIRVIEW, MD	06/07/94	06/19/96	6	2	0.13
01614525	ROCKDALE RN AT FAIRVIEW, MD	09/08/93	09/08/93	1	0	
01615520	TOWN RN AT WINCHESTER, VA	09/08/93	09/08/93	1	0	
01616500	OPEQUON CREEK NR MARTINSBURG, WV	06/07/94	06/07/94	1	0	
01617010	TUSCARORA C AT MARTINSBURG, WV	09/07/93	09/07/93	1	0	
01617800	MARSH RN AT GRIMES, MD	09/07/93	09/07/93	1	0	
01618200	RATTLESNAKE RN NR SHEPHERDSTOWN, WV	09/08/93	09/08/93	1	0	
01619140	MARSH RN AT REID, MD	09/07/93	09/07/93	1	0	
01619200	HAMILTON C AT HAGERSTOWN, MD	09/07/93	09/07/93	1	0	
01619500	ANTIETAM C NR SHARPSBURG, MD	06/07/94	06/07/94	1	0	
01620500	NORTH R NR STOKESVILLE, VA	08/09/95	08/09/95	1	0	
01620850	MOSSY C NR SPRING CREEK, VA	09/14/93	09/14/93	1	0	
01620995	BLACK RN AT RAWLEY SPRINGS, VA	08/10/95	08/10/95	1	0	
0162101710	SW-04 MUDDY CREEK FLOWPATH STUDY, VA.	06/09/95	06/09/95	1	0	
0162101730	SW-05 (CONFLUENCE) MUDDY CREEK FLOWPATH STUDY, VA.	06/23/94	06/23/94	1	0	
0162101750	SW-03 MUDDY CREEK FLOWPATH STUDY, VA.	06/08/95	06/08/95	1	0	
0162101790	SW-01 MUDDY CREEK FLOWPATH STUDY, VA.	06/23/94	06/07/95	7	0	
01621050	MUDDY C AT MOUNT CLINTON, VA	03/29/93	05/10/95	39	0	
01621400	BLACKS RUN AT HARRISONBURG, VA	09/09/93	09/09/93	1	0	
01622000	NORTH RIVER NEAR BURKETOWN, VA	06/06/94	06/06/94	1	0	
01624490	LEWIS C AT STAUNTON, VA	09/09/93	09/09/93	1	0	
01624670	FOLLY MILLS CREEK NEAR STAUNTON, VA	09/09/93	09/09/93	1	0	
01624950	POLECAT DRAFT NR PIEDMONT, VA	09/13/93	09/13/93	1	0	
01625000	MIDDLE RIVER NEAR GROTTOES, VA	06/23/92	06/06/94	2	0	
01626950	PORTERFIELD RN NR CRIMORA, VA	09/13/93	09/13/93	1	0	
01627500	SOUTH RIVER AT HARRISTON, VA	06/06/94	06/06/94	1	0	

01629500	S F SHENANDOAH RIVER NEAR LURAY, VA	06/07/94	06/07/94	1	0		
01629550	MILL C NR HAMBURG, VA	09/10/93	09/10/93	1	0		
01631020	SF SHENENDOAH RIVER BL CABIN RUN AT FRONT ROYAL VA	06/08/94	06/08/94	1	0		
01631700	SHOEMAKER R NR FULKS RUN, VA	08/10/94	08/10/94	1	0		
01632750	HOLMANS RN AT QUICKSBURG, VA	09/09/93	09/09/93	1	0		
01633000	N F SHENANDOAH RIVER AT MOUNT JACKSON, VA	06/07/94	06/07/94	1	0		
01633730	TOMS BROOK AT TOMS BROOK, VA	06/07/94	06/07/94	1	0		
01634000	N F SHENANDOAH RIVER NEAR STRASBURG, VA	09/08/93	09/08/93	1	0		
01634100	PADDY RN NR LEBANON CHURCH, VA	08/09/95	08/09/95	1	0		
01635045	BUFFALO MARSH RUN NEAR MIDDLETOWN, VA	09/08/93	09/08/93	1	0		
01636215	HAPPY C AT CROSBY STADIUM AT FRONT ROYAL, VA	09/10/93	09/10/93	1	0		
01636305	PAGE BK AT BOYCE, VA	09/08/93	09/08/93	1	0		
01636460	BULLSKIN RUN ABOVE KABLETOWN,WV	09/08/93	09/08/93	1	0		
01636500	SHENANDOAH R AT MILLVILLE, WV	03/30/93	09/10/96	22	0		
01637950	BROAD RN NR JEFFERSON, MD	08/24/94	08/24/94	1	0		
01638050	CATOCTIN C AT OLIVE MD	06/16/94	06/16/94	1	0		
01638450	RICHARD C NR WATERFORD, VA	08/24/94	08/24/94	1	0		
01638480	CATOCTIN C AT TAYLORSTOWN, VA	06/08/94	07/07/94	2	0		
01638740	MUMMASBURG RN NR GETTYSBURG, PA	08/25/94	08/25/94	1	0		
01638895	WHITES RN NR TWO TAVERNS, PA	08/25/94	08/25/94	1	0		
01638920	LITTLES RN NR GETTYSBURG, PA	08/25/94	08/25/94	1	0		
01638994	ALLOWAY C NR HARNEY, MD	08/25/94	08/25/94	1	0		
01639000	MONOCACY R AT BRIDGEPORT, MD	06/03/92	06/21/96	40	4	0.029	0.005
01639380	FLAT RN AT EMMITSBURG, MD	08/25/94	08/25/94	1	0		
01639400	BIG PIPE C AT BACHMAN MILLS, MD	08/30/94	08/30/94	1	0		
01639440	SILVER RN NR SILVER RUN, MD	08/30/94	08/30/94	1	0		
01639462	BEAR BRANCH NR FRIZZELLBURG, MD	08/25/94	08/25/94	1	0		
01640000	L PIPE C AT AVONDALE, MD	08/25/94	08/25/94	1	0		
01640155	SAMS C NR UNION BRIDGE, MD	08/25/94	08/25/94	1	0		
01641930	GLADE C NR WALKERSVILLE, MD	08/25/94	08/25/94	1	0		

01642200	CARROLL C AT FREDERICK, MD	08/25/94	08/25/94	1	0		
01642425	SF LINGANORE C AT LINGANORE, MD	08/25/94	08/25/94	1	0		
01643020	MONOCACY R AT REICHS FORD BRIDGE NR FREDERICK	06/08/94	06/21/96	5	3	0.023	
01643300	BENNETT C NR HYATTSTOWN, MD	08/24/94	08/24/94	1	0		
01643615	BROAD RN AT ELMER, MD	08/24/94	08/24/94	1	0		
01643705	CROMWELL RN NR ATOKA, VA	08/24/94	08/24/94	1	0		
01643800	N F GOOSE C NR LINCOLN, VA	08/24/94	08/24/94	1	0		
01643820	BEAVERDAM C NR UNISON, VA	08/24/94	08/24/94	1	0		
01644000	GOOSE C NEAR LEESBURG, VA	06/09/94	06/09/94	1	0		
01644481	GREAT SENECA C AT GOSHEN, MD	08/24/94	08/24/94	1	0		
01645725	DIFFICULT RN NR VIENNA, VA	08/24/94	08/24/94	1	0		
01646350	CABIN JOHN C AT ROCKVILLE, MD	08/24/94	08/24/94	1	0		
01646580	POTOMAC R AT CHAIN BRIDGE, AT WASH, DC	06/09/94	09/10/96	10	1	0.019	–
01647720	NB ROCK C NR NORBECK, MD	08/24/94	08/24/94	1	0		
01648000	ROCK C AT SHERRILL DRIVE WASHINGTON, DC	08/24/94	08/24/94	1	0		
01649200	PAINT B AT COLLEGE PARK, MD	08/24/94	08/24/94	1	0		
01650900	SLIGO C AT TAKOMA PARK, MD	08/23/94	08/23/94	1	0		
01652370	FOURMILE RN AT ARLINGTON, VA	08/23/94	08/23/94	1	0		
01654000	ACCOTINK C NEAR ANNANDALE, VA	03/16/94	08/06/95	41	0		
01656102	GOSLIN RN NR ADEN, VA	08/23/94	08/23/94	1	0		
01656655	KETTLE RN NR NOKESVILLE, VA	08/23/94	08/23/94	1	0		
01656725	BULL RN NR CATHARPIN, VA	08/24/94	08/24/94	1	0		
01656772	FLAT BRANCH AT MANASSAS PARK, VA	08/23/94	08/23/94	1	0		
01656870	CUB RN AT OLD LEE RD. NR CHANTILLY, VA	08/24/94	08/24/94	1	0		
01656920	FLATLICK BRANCH NR CHANTILLY, VA	08/24/94	08/24/94	1	0		
01657435	WOLF RN NR CLIFTON, VA	08/23/94	08/23/94	1	0		
01658500	S F QUANTICO C NR INDEPENDENT HILL, VA	08/23/94	08/23/94	1	0		
01659000	N B CHOPAWAMSIC C NR JOPLIN, VA	08/23/94	08/23/94	1	0		
01660350	AQUIA C NR GARRISONVILLE, VA	08/23/94	08/23/94	1	0		

01661050	ST CLEMENT C NR CLEMENTS, MD	06/01/92	06/01/92	1	0

Table IV-3. Summary of monitoring data from the San Joaquin-Tulare Basin.

Site	Start Date	End Date	Number of Samples	Number of Detects	Max Conc.	TWOM	TWAM 1992	19
SAN JOAQUIN R NR STEVINSON CA	06/20/94	06/20/94	1	0				
SALT SLOUGH A HWY 165 NR STEVINSON CA	01/20/93	06/21/94	27	0				
MUD SLOUGH NR GUSTINE CA	06/21/94	06/21/94	1	0				
MERCED R BL MERCED FALLS DAM NR SNELL CA	06/18/94	06/18/94	1	0				
MERCED R A RIVER ROAD BRIDGE NR NEWMAN CA	01/22/93	06/22/94	61	1	0.056			0.0
ORESTIMBA C NR NEWMAN CA	02/17/93	02/18/93	2	0				
ORESTIMBA CR AT RIVER RD NR CROWS LANDING CA	04/15/92	03/02/95	100	41	0.39		0.026	
SPANISH GRANT COMBINED DRAIN NR PATTERSON CA	06/22/94	06/22/94	1	1	1			
TURLOCK IRR DIST LATERAL NO 5 NR PATTERSON CA	04/29/92	06/22/94	25	13	0.08			
SAN JOAQUIN R A PATTERSON BR NR PATTERSON CA	06/09/94	07/06/94	5	1	0.077			
DEL PUERTO C AT VINEYARD ROAD NR PATTERSON	06/23/94	06/23/94	1	0				
TUOLUMNE R A MODESTO CA	01/04/94	03/21/95	28	0				
TUOLUMNE R A TUOLUMNE CITY NR GRAYSON CA	02/09/94	02/09/94	1	0				
STANISLAUS R A RIPON CA	12/27/93	06/23/94	22	0				
SAN JOAQUIN R NR VERNALIS CA	04/22/92	03/21/95	91	13	0.079	0.0043	0.003	0.0
BEAR C A BERT CRANE RD NR MERCED CA	06/18/94	06/18/94	1	0				
NEWMAN WASTEWAY A HWY 33 NR GUSTINE CA	06/22/94	06/22/94	1	1	0.013			
STEVINSON LOWER LATERAL NR STEVINSON CA	02/08/94	02/08/94	2	0				
HIGHLINE CN SPILL NR HILMAR CA	02/08/94	06/21/94	3	0				
LIVINGSTON CN A LVNGSTN TRMNT PLANT NR LVNGSTN CA	02/08/94	06/20/94	3	0				
OLIVE AVE DR NR PATTERSON CA	06/23/94	06/23/94	1	1	0.25			
WESTPORT DRAIN NR MODESTO CA	06/23/94	06/23/94	1	0				
SAN JOAQUIN R BL WSID PMP AB TUOL R NR WESTLEY CA	06/09/94	06/28/94	4	1	0.046			
TUOLUMNE R A CARPENTER RD BRIDGE A MODESTO CA	02/13/95	02/13/95	16	0				
TURLOCK ID CERES MAIN SPILL NR CERES CA	02/14/95	02/14/95	1	0				
TUOLUMNE R A MITCHELL RD BRIDGE A MODESTO CA	02/13/95	03/11/95	5	0				
WEST SIDE STORMDRAIN A NEECE DRIVE A MODESTO CA	02/13/95	02/13/95	1	0				
INGRAM C (AT R RD) CA	06/24/94	06/24/94	1	0				
NINTH ST STORMDRAIN A SEVENTH ST BR A MODESTO CA	02/13/95	02/13/95	1	0				
TURLOCK ID HICKMAN SPILL NR HICKMAN CA	02/14/95	02/14/95	1	0				
TUOLUMNE R A ROBERTS FERRY BR NR ROBERTS FERRY CA	02/14/95	02/14/95	1	0				
DRY C A GALLO BRIDGE BL HWY 132 A MODESTO CA	02/13/95	03/10/95	6	0				
HOSPITAL C (AT R RD) CA	06/23/94	06/23/94	1	0				
MCHENRY STORMDRAIN A BODEM ST A MODESTO CA	02/13/95	02/14/95	6	0				
SONOMA STORMDRAIN A SCENIC DRIVE A MODESTO CA	02/13/95	02/13/95	1	0				
DRY C A CLAUS RD BRIDGE A MODESTO CA	02/13/95	03/11/95	8	0				
FARABUINDO STORMDRAIN A CLAUS RD A MODESTO CA	02/13/95	02/13/95	1	0				
OAKDALE ID DRAINAGE A ELLENWOOD RD NR WATERFORD CA	02/14/95	02/14/95	1	0				
DRY C A LEASK BRIDGE BL CASHMAN C NR WATERFORD CA	02/14/95	02/14/95	1	0				
STANISLAUS R A CASWELL STATE PARK NR RIPON CA	02/09/94	02/09/94	1	0				

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Data Basis

<u>EFED Incident Data System</u>

<u>EFED Endangered Species Data Base</u> (updated 10/1/92).